MONTANA RENEWABLE ENERGY HANDBOOK

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MONTANA RENEWABLE ENERGY HANDBOOK

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In the process of reviewing the three major energy conversion categories of fossil energy, nuclear energy, and renewable energy, the Montana Energy Advisory Council has become aware that renewable energy not only offers some very exciting opportunities for Montana in both the short and the long run, it also is an area about which many of us know very little. Thus, it was decided that as long as this type of information was needed by the Energy Advisory Council in recommending policy actions, a handbook of general interest material would be published as an interim report.

Most of the substantive work on this handbook was done by Kye Cochran of the Alternative Energy Resources Organization (AERO). For that and the help of those listed below, the State of Montana is most appreciative. Additional help from:

James Baerg of AERO
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Angela Mueller
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Jim Nybo
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Randy Reinhart of AERO
Sharon Solomon
Wilbur Wood of AERO

CONTENTS

THIS HANDBOOK

How To Use It

This booklet is a very basic guide, and as such it cannot contain real depth of information on any of the topics it covers. However, it does provide a very comprehensive list of references at the back. The reference section is divided into sections, with numbered references under each section. After each question in this booklet (and after some statements also), a list of references is given in parentheses; these are the references we suggest for further reading or consultation on the subject. For instance, after the first question on solar energy we have (A1, A6-h, C1). This means there is more information on solar electricity production in Energy for Survival, The Solar Energy Working Paper of the Montana Energy Conservation Plan, and The Dawning of Solar Cells, listed in the references.

Our references consist of publications, periodicals, people and organizations. Publications are COMPLETELY CAPITALIZED; periodicals are Underlined; and people and organizations are simply listed.

We have put an * before the references which we use the most ourselves and ** before those AERO has for sale in Billings.

You can always come to AERO for more information; just assume that it is cited after each of the questions, because we are a source for further reference on all topics covered.

ONE OF THE MOST COMPREHENSIVE DOCUMENTS on renewable energy for Montana is the very recently completed Montana Energy Conservation Plan (A6). This Plan, funded by the Federal Energy Administration and sponsored by the Montana Energy Advisory Council, was completed in January, 1977 by a team consisting of Patrick Binns, energy legislation consultant from Helena; John McBride, Susan Brown and Karen Barclay from the Montana Energy & MHD Research, Development & Demonstration Institute in Butte; and researchers from the Ecotope Group, a renewable energy research and consulting organization from Seattle, Washington. Much reference is given in this Handbook to the Montana Energy Conservation Plan (A6) and its accompanying working papers (A6-a through A6-p).

STEP #1 FOR EVERYONE: CONSERVATION

Energy conservation practices must be the basic foundation upon which we build future energy systems-- whether they use conventional or renewable energy. According to economist Denis Hayes (B1), "In 1975, Americans wasted more fuel than was used by 2/3 of the world's population. We annually consume more than twice as much fuel as we need to maintain our standard of living. We could lead lives as rich, healthy and fulfilling -- with as much comfort, and with more employment -- using less than half the energy now used...Energy derived from conservation would be safer, more reliable, and less polluting than energy from any other source."

For these reasons, we would like to include energy conservation information in this handbook; but we don't have enough room. However, our references at the back of the book include good sources for energy conservation information. (A6, B1, B2, B3, B4)

WHY RENEWABLE ENERGY?

The fossil energy sources which now support this country-- and this state-- are non-renewable. It has become clear that the fuels we use the most--petroleum and natural gas--are being depleted so fast that they will be effectively exhausted within 50 years (A1). At present, these two fuels provide 3/4 of all the energy consumed in the United States; the reason for this is that until very recently they have been inexpensive. However, in the last few years oil and natural gas costs have increased: foreign producers have raised their prices, and the supply in the U.S. of these finite fuels has begun to run out. There is controversy over the forecast pace of price hikes, but there is no doubt that energy will become increasingly expensive in the future.

Several factors in our energy problem are important:

1) The U.S. is by far the worst energy waster of any country in the world. "Our dependence on massive resource use has been so total that most Americans cannot conceive of operating on as little as 1/3 the energy we use--though quite civilized countries such as New Zealand, Sweden, Switzerland, Japan and France do so quite well. It remains totally incomprehensible to us that a society can operate adequately on 10%, 5%, or even 1% of the energy and wealth that we demand, yet hundreds of millions of people do so and have always done so. Ironically, our ineffective use of energy, the improvident ends to which we have used it, and the increasing inefficiency of our institutions has resulted in our quality of life actually becoming in many ways lower than that of other nations consuming only a fraction of the energy we do...Our health standards, the quality of our surroundings, the use of time, the efficiency of our industry have all fallen below that of many countries." (A6, A9, B1)

   The case of Sweden is particularly instructive: Sweden is heavily industrialized, is located in a cold climatic region, and uses only 48% of the energy per capita that we use. And even by the measure so often used as a yardstick for national wealth--gross national product--Sweden beats us: it has recently been shown to have a slightly higher standard of living than the U.S.

   A 1975 study on U.S. energy conservation possibilities financed by the Federal Energy Administration and published by the World Watch Institute found that a vigorous national program of energy conservation could enable America to meet all its fuel and electricity needs for the next 25 years without becoming hooked on imported oil or hazardous nuclear technology. According to the report, "Energy conservation does not mean going without; it means going further with what we have," and it says that the U.S. energy budget could be gradually cut by more than half without altering the nation's standard of living: "A strong national conservation program can contribute to human health, create employment opportunities, and lead to a more stable and sustainable national economy."(A6, B1)

2) The second factor in our energy dilemma of which we should be aware is that 1/4 of all the energy consumed in America is used for heating and cooling of buildings and heating domestic hot water supplies. Heating and cooling requires the maintenance of a maximum temperature differential between inside and outside of no more than 110° in Montana, much of which can be accomplished with thermal insulation, appropriate design and minimal energy inputs. Similarly, domestic hot water requires raising inlet water temperatures by 80° or 90° Fahrenheit. We could accomplish this sort of heating easily with low-grade thermal energy, but we are now burning our highest grade fuels for these purposes. Petroleum and other fossil resources are needed for plastics, medicines, cosmetics, vitamins, dyes and other goods; why burn these hydrocarbons for heat when we can do the same job with lower-grade thermal energy more suited to the task? (A6)

Solar energy is particularly suitable to the low-grade heat-energy requirements of buildings, since it can be collected, converted and used all at one location. A person can make use of this on-site energy resource with a building design that admits sunlight into the interior when heat is wanted; with special mechanical systems that convert sunshine into heat for direct use or storage; or with a combination of both. The initial costs for solar systems which include 'solar hardware' (solar collectors, distribution and storage system) are higher than costs of conventional systems which use non-renewable energy instead of the on-site energy potential; but the total costs incurred over the life of the building are often lower in the case of solar because of the negligible fuel costs. In many regions of the country--including Montana--solar heating is already cheaper on a life-cycle basis than either propane or electric resistance heating. (A6-h)

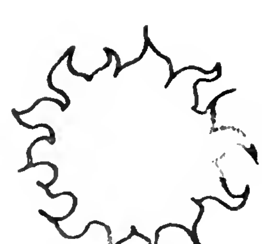
Solar energy flowing daily to us from the sun is a renewable resource. It cannot be depleted through use; it will be available as long as there is life on earth. Sunlight is an enormous but low-intensity energy resource that is available over the entire earth's surface, and is the source of the other renewable energies of plant life, winds, and flowing water.

These natural energy flows would not introduce heat imbalances on earth as does the release of heat from fossil or nuclear-fueled power plants. While there are impacts associated with the production of materials (steel, copper, fiberglass, plastics) used in solar energy systems, the long-term ecological impact of operating such technologies is negligible since fuel is not burned or irradiated. Once installed, solar conversion equipment does not further the depletion of non-renewable resources, or pollute the land, air or water.

In comparison, the fossil fuel and nuclear alternatives require significant material inputs for constructing the interdependent networks which extract and refine the fuel, and then convert and deliver it to the consumer. Once this complex system is built, energy can be provided only through the continued energy-intensive work of supplying the fuel and of finding new deposits. In each of these steps the environment is altered, either by a changing of the landscape or by the introduction of chemical, thermal or radioactive byproducts released by the conversion process. The cost--both in energy and in money--of repairing the damage caused by these pollutants, is enormous; who will pay it? Wherever that burden is placed, it is obvious that we must calculate carefully the ecological impacts of renewable versus non-renewable energy conversion to compare both short and long-range benefits and costs.

We must improve the efficiency of energy use, and at the same time work toward a conscious changeover to technologies and lifestyles which more fully utilize Earth's renewable energy flows. It makes sense that a sustainable energy network should be decentralized; thus the energy-user is compelled (and allowed) to match his energy demand with the renewable energy supply, and he has more control over, and more responsibility for, his personal energy use.

Local conversion and use of incoming energy will substantially reduce the need for costly long-distance transmission systems; it will decrease the society's vulnerability to disruptions of its energy supplies due to technical or human error, sabotage, natural disaster, or war.



SOLAR ENERGY

1. In What Ways Can Solar Energy Substitute for the Fossil Fuels We Now Use?

   a. It can produce electricity. Solar energy can be used to produce electricity either (1) through the use of concentrating collectors which focus and intensify the sun's rays so that the heat can be used to make steam and run turbines, or (2) through the use of photovoltaic cells - which actually turn the sun's light into electricity. Both methods are costly and in need of some further development, but rapid progress is being made; experts are predicting great cost reductions within the decade. (A1, A6-h, C1)
   b. It can heat and cool homes. (A2, A4, A6-h, C6)
   c. It can heat water. (A2, A7, A6-h, C6)
   d. It can dry food and crops. (A2, A7, C8)
   e. It can regulate temperatures in greenhouses. (C3, C6)
   f. It can cook food. (C4)
   g. It can provide heat for many manufacturing processes. (A6-h)

2. Which can be used now in Montana?

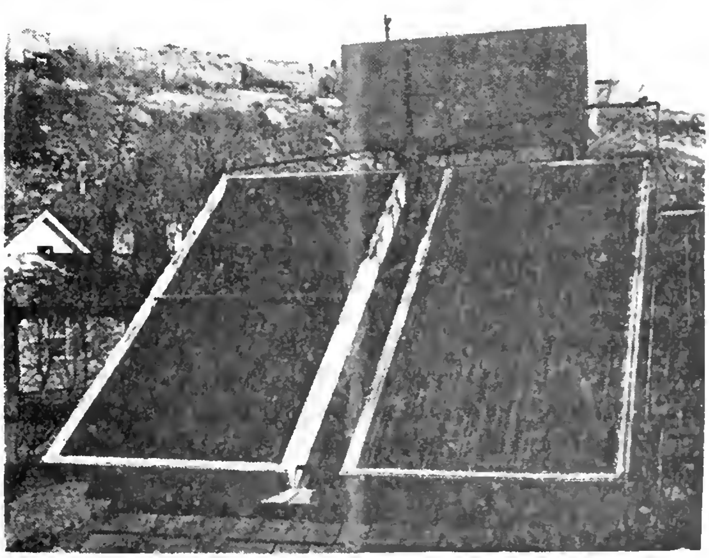
   a. Solar space heating, using 'passive' systems, flat plate collectors (also called solar panels), or reflector-assisted flat plate collectors.
   b. Solar water heating, using flat plate collectors, concentrating collectors, or reflector-assisted flat plate collectors.
   c. Solar food and crop drying.
   d. Solar greenhouses.
   e. Solar ovens and cookers.

3. What is a passive solar system?

In designing a 'passive' solar heating system, a person attempts to divert natural energy flows to his benefit without the application of solar 'hardware' such as collectors, pumps, heat exchangers, etc. Solar heat coming through windows, skylights, clerestories, etc., is used or stored and used later to offset a large part of the building's heating requirement. According to a computer model developed at Los Alamos Scientific Labs in New Mexico, a well-designed passive solar system can achieve performances comparable to an active system--and for a far lower cost! (C6)

4. What are flat plate collectors?

A flat plate collector is essentially a blackened surface which will absorb the sun's rays and transfer the heat to either water or air that is passed over it. A typical flat plate collector for heating water would consist of: (1) a corrugated sheet of metal about 4 feet by 8 feet, painted flat black on top, insulated underneath, and housed in a wooden box; (2) a net work of piping attached to the metal, which will bring the water in, allow the heated metal to heat the water, and take the heated water away to a storage area; (3) one or two layers of glass (single or double glazing) fitted onto the box an inch above the black metal surface, to keep in the heat. (A2, A6-h, A7)



SOLAR PANELS ON A HOME IN BILLINGS, MONTANA

5. What are reflector-assisted flat plate collectors?

These are regular collectors which are made more effective by the use of reflective panels; these are placed at a strategic angle to focus more than the usual amount of sunlight onto the collectors. A man named Henry Mathew lives in a home which uses reflector-assisted flat plate collectors very successfully in Coos Bay, Oregon--a part of the country which a person would expect to have very little solar heating potential. Reflectors have also been used to assist in passive solar heating. (A6-h)

6. How many square feet of collector do I need for home heating with an 'active' solar system?

The general rule is: 1/4 to 1/3 the floor area of your house. But this is dependent on climate and on the design of the house, and reflectors can help to cut down the area needed. One reason we stress energy conservation so heavily is that solar collectors can be quite expensive. It makes more economic sense to insulate a home and use less energy than to spend more to produce extra energy because some of it is going to be wasted.

7. How many square feet of collector do I need for water heating?

It depends on how much hot water you use. A 4' x 8' flat plate collector will heat 40-50 gallons of water in a day.

8. Can I buy solar flat plate collectors?

Yes. The number of companies selling solar hardware increases every month. As yet, no one in Montana is manufacturing solar systems or components, but there are several outfits selling various systems (A25). In 1975 the U.S. Energy Research and Development Administration produced a catalog (ERDA-75) of solar manufacturers in the U.S. An updated directory is available from the Solar Energy Industries Association (A24).

9. How much would solar flat plate collectors cost?

Commercial collectors cost anywhere from \$6/square foot to \$15/square foot. You must add to that the cost of storage system, pumps and controls. In general, a complete heating system can cost 25% the cost of a house, or 10-15% of the cost of a commercial building. However, with the lessening of your fuel bill, the payback period on a solar system is about 10 years. (A2, A7, C6)

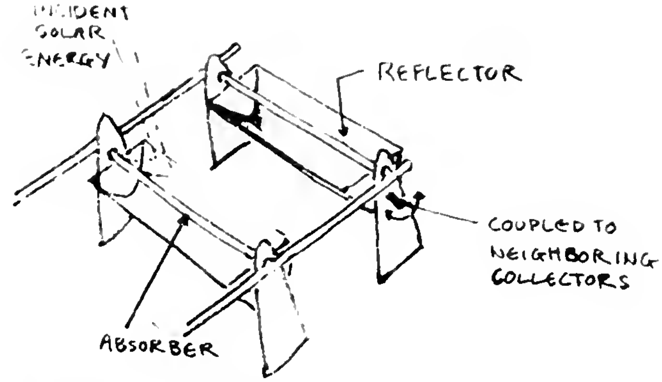
10. What about solar cooling?

'Solar' cooling can be done by an absorption process similar to that used in absorption refrigeration. This has not been developed yet to a commercial stage for cooling buildings, but significant work in this area is being done, particularly at the Solar Energy Lab at the University of Florida. Natural cooling can be done through judicial placement of trees and bushes around a home; through night sky radiation (allowing heat to leave a building at night, and keeping the cooler night air in the building in the daytime); and through evaporation of water (as with a 'swamp cooler'-type air conditioner). (A2, A7, C6)

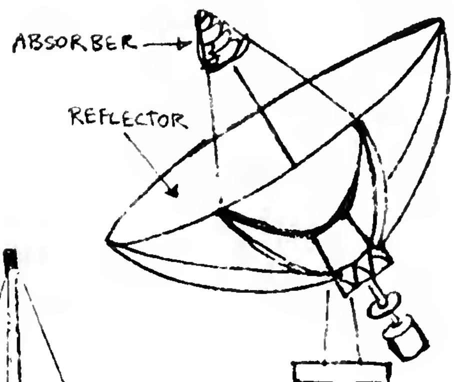
11. What is a solar 'concentrating' collector?

Concentrating collectors use reflective surfaces or lenses to concentrate sunlight onto a relatively small area. They can achieve substantially higher temperatures (to 6000° F) than can flat plate collectors. Concentrating collectors can be divided into 3 groups. (A2, A6-h, A7)

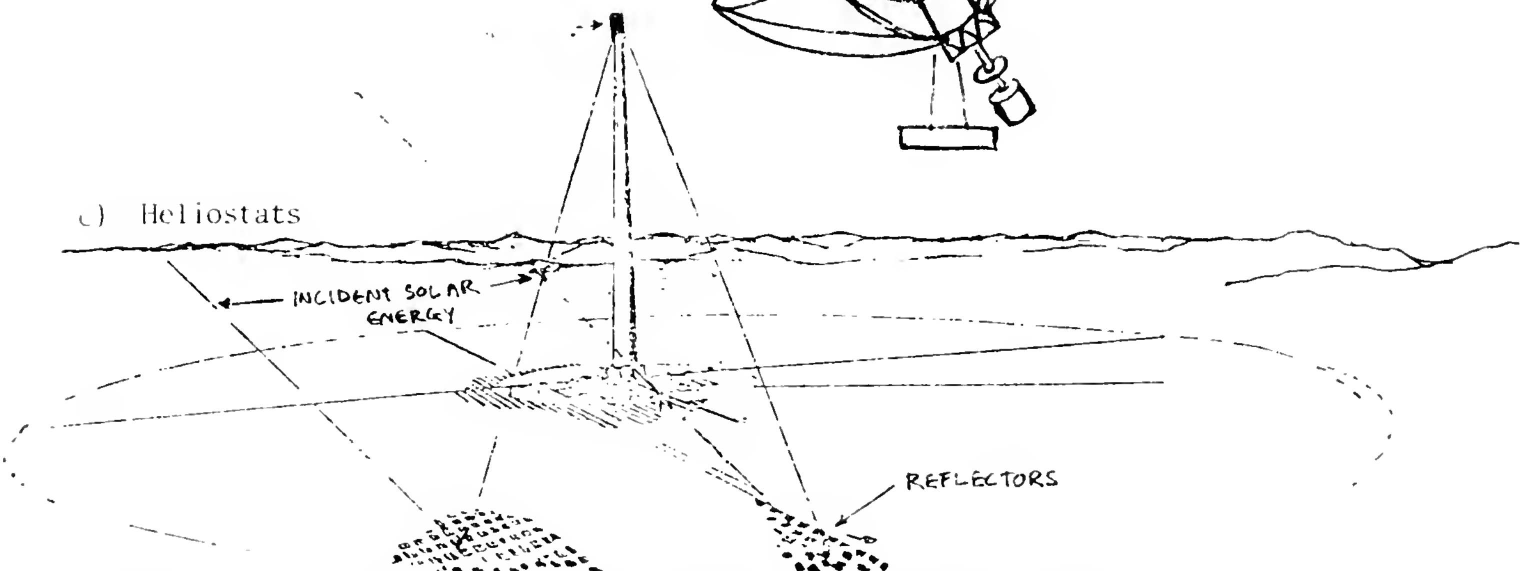
a) Linear or Trough Collectors



b) Parabolic Collectors



c) Heliostats



12. How do concentrating collectors compare with flat plate collectors in efficiency for Montana's conditions?

According to the research team which produced Montana's Energy Conservation Plan in early 1977, "Systems which involve concentration and/or tracking perform relatively better in Montana than do the traditional flat plate collection systems." (A6-h) Appendix # 7on p.34 is table describing solar energy collection options.

13. Can I put solar flat plate collectors on my existing house?

The first, most important and least costly way of helping keep your home warm is to tighten it up and be sure it is well insulated. After that, depending on how your home is situated (a good roof or side area facing south is best) you can add solar devices. You should read up on it and/or get some consultation before you proceed. (C6)

14. Can I build solar flat plate collectors myself?

Yes. Flat plate collectors are not complicated. There is a great cost savings in building your own. Materials are off-the-shelf. AERO has held workshops in which citizens across the state built perfectly good water-heating flat plate collectors--and air-heating ones are simpler and cheaper yet. However, you must remember that

the solar panel is not the entire system; you must pay very careful attention to climate, location, situation, insulation, and engineering of your entire system if you are to get full value from your solar flat plate collectors.

15. How do I store solar heat?

Since periods of little or no sunshine are inevitable, it is necessary to include a heat storage system for a solar heated building. The most commonly used types are large tanks of water or large bins of small rocks. Hydrated ('Glaubers') salts can be used, but a method of extending the (as yet rather short) lifetime of this medium is yet to be perfected. (A1, A2, A7, C6)

The rule of thumb for size of storage in an 'active' system is: 2-3 gallons of water or 1/2 cubic foot (100 lb.) of rock for each square foot of collector. The rule of thumb for 'passive' systems is: as much storage material (thermal mass) as you can find room for.

16. Can solar energy provide all of my space heating?

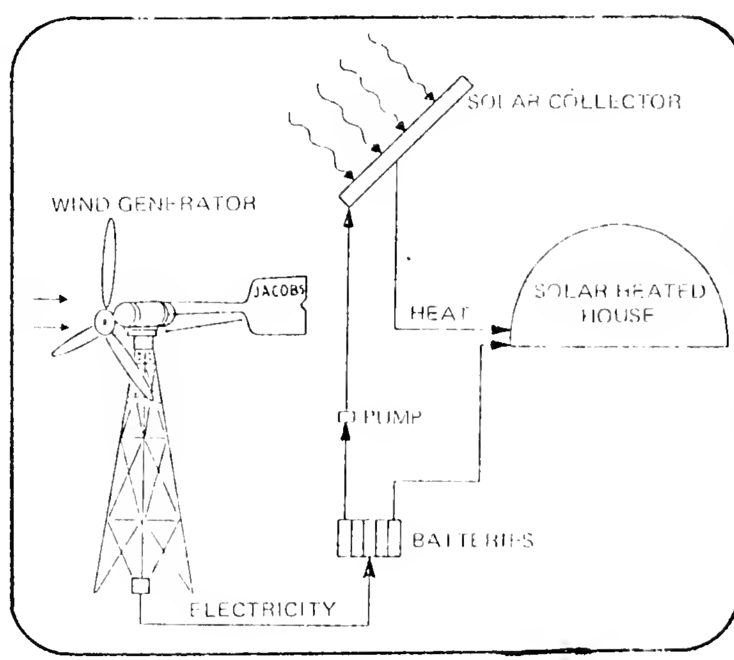
Yes, but it is generally not economically viable, because of the massive storage and collector space involved. For example, a given size collector could provide 50% of your heating; but doubling the size would only provide 70-80% (with proper insulation, etc.). Doubling the collector and storage (and cost) doesn't double the results. It is generally accepted that a person should have a wood or fossil fuel back-up system. (A2, A7, C6)

17. What about industrial uses of solar energy?

Solar energy concentrated by mirrors can reach over 6000° F., as demonstrated by a solar furnace in the Pyrenees in France. Solar energy could be used both on a small and on a large scale for smelting metals, for glass production, and for industrial processes which use low-grade steam heat. (A6-h)

18. Can I combine other renewable energy systems with solar?

Yes. No single renewable energy source is likely to be able to supply all your energy needs; thus, it is most sensible to use energy from various sources for various 'energy jobs': A solar collector can heat water and space; a solar greenhouse can produce food and help heat space; a solar dryer can dry food or crops; a solar concentrator can cook food; a water wheel can produce mechanical power; a water turbine can produce electricity; a wind generator can produce electricity; a windmill can pump and provide mechanical power; a methane digester can produce combustible fuel and good fertilizer; and wood can produce heat. Many people are designing integrated systems which use various of these energy sources and devices to provide total energy input.



A combined renewable energy system

19. What are solar greenhouses?

Most commercial greenhouses use a good deal of fossil fuel for supplementary heating and cooling. In solar greenhouses, temperatures are regulated in much the same way as in passively heated and cooled solar houses: they have a large double-glazed glass area facing south; they have no glass on the north side, and it is heavily insulated; they contain a large amount of 'thermal mass' (bins of rocks, barrels of water, etc.); they have a well-designed ventilation system (which in appropriate cases can be used to help heat an adjacent building) to keep them from overheating. (C3, C6)

20. Does Montana offer assistance to citizens wishing to install or build renewable energy systems?

As of 1976, Montana has 2 laws which aid residents interested in using renewable energy resources:

1. The Montana Alternative Renewable Energy Research, Development and Demonstration Act (S.B. 86). This law provides that money from 2½% of Montana's coal tax be granted to Montana residents who wish to conduct research into, develop, or demonstrate renewable energy devices and systems. Grants of not more than $100,000 and for a period of not more than a year will be administered by the Montana Department of Natural Resources and Conservation.
2. House Bill 663. This law exempts from property taxation the amount of any capital investment in a defined non-fossil form of energy generation (specifically solar heat, wind, solid wastes, organic wastes, and small water power systems). The appraised value of the investment may not exceed $100,000.

For a copy of either of these laws, write to the Montana Dept. of Natural Resources (A35).

21. Does the Federal Government offer assistance to people wishing to install or build solar energy devices or systems?

The U.S. Research and Development Administration (ERDA) is in charge of the Solar Heating and Cooling Act of 1974, which provides grant money for the construction of buildings to research, develop and demonstrate various systems for solar heating and cooling. The administration of grants for residences under this Act is delegated to the U.S. Housing and Urban Development (HUD). Grants do not go to individuals for private residences, but rather to contractors or builders for homes not already sold. For more information on this project, contact Solar Energy Program, Room 8158, HUD, Washington, D.C. 20410. The best way to keep up with Federal activities in solar energy is to read SUN, Solar Energy Intelligence Report, Solar Age, or Solar Engineering (A22, C13, C11, C14) The U.S. Energy Research and Development Administration's Division of Solar Energy reports on its activities in a free 4-page periodical (A24)

22. Are other states passing legislation regarding solar energy?

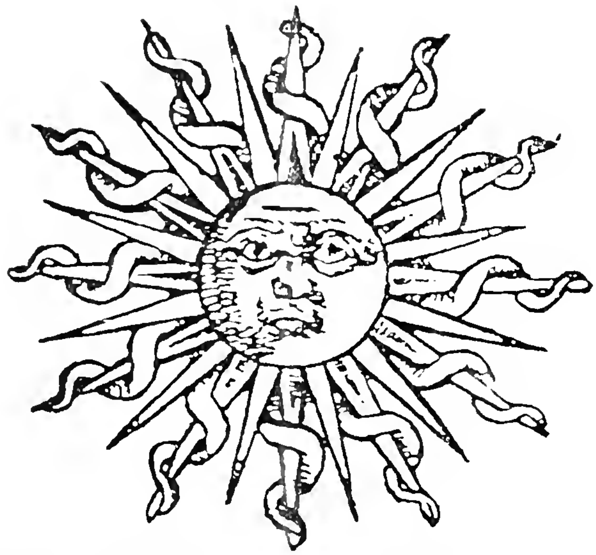
Yes. There is extensive activity in this area in many states; they are passing legislation establishing tax breaks, changing building codes, financing research and development, financing informational and promotional activities, and financing building construction. Two excellent sources for information on this are: Turning Toward the Sun, and the Council of State Governments' Energy Legislation periodical. (C10, A14)

23. Where can I get good data on Montana's solar resource?

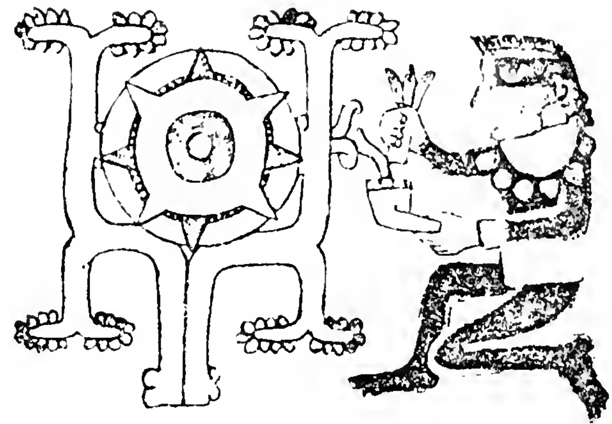
There are only two places in Montana where the amount of incoming solar radiation is recorded: in Great Falls, it is recorded hourly, and in Glasgow it is recorded daily. The Montana Energy Conservation Plan (A6-h) contains a compilation of existing data.

Because of the lack of data, it is difficult to predict a solar energy system's performance in other areas of Montana; however, general insolation (amount of sunlight received) charts compiled for all of America show that Montana has plenty of sunshine in most areas to provide space- and water-heating for buildings.

A high priority in beginning a serious renewable energy program for Montana should be the establishment of a network of resource data-gathering stations.



In Medieval Europe the sun was often depicted as a human face surrounded by rays.



The early Aztec Sun God was Quetzalcoatl. Here the sun is pictured among the branches of the tree of life.

WIND ENERGY

1. Does Montana have good winds?

   Yes. Many parts of Montana have as good a wind resource as is found anywhere in the country. According to Montana's Energy Conservation Plan, "If wind potential was developed intensively, it would produce about 25 times the total current energy use of the State...Montana is one of the first places where windpower will be developed, probably in the 1980's." (A6-i)

   Unfortunately, as is the case with solar radiation, we don't have a wind energy survey program in Montana; the only statistics on wind speed and frequency are to be found at airports, which are generally located in low-wind areas. The best compilations and analysis of Montana wind statistics are in John Obermeier's thesis, Wind Electric Power for Montana cited in the wind power working paper of the Montana Energy Conservation Plan (D3, A6-i)

2. What's a good average wind speed, and how do I find out if I've got good winds?

   An average wind speed of 10 miles per hour or more is considered to be "good wind" for

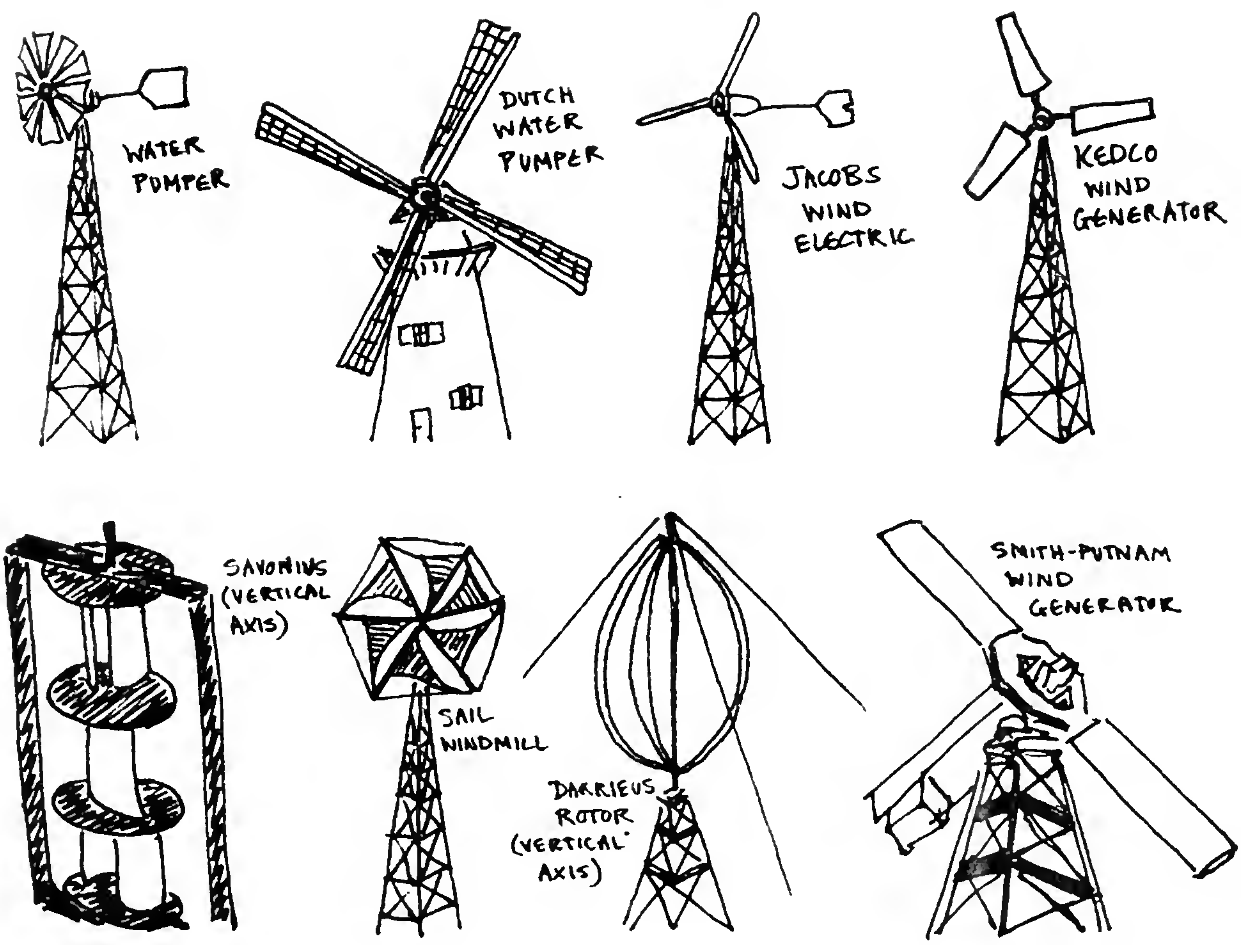
generating electricity. A person should use an anemometer and some kind of recording device to collect wind speed data in the desired location for at least 3 months before deciding whether or not to use a wind generator.

3. What's the difference between a windmill and a wind generator?

The term 'windmill' is used loosely to designate wind machines which either convert the wind power to mechanical energy for pumping, grinding, etc., or convert it to electrical energy. 'Wind generator' is used exclusively to designate a wind machine that produces electricity. Mechanical windmills generally have many blades, will start in very little wind, and have great strength (torque); wind generators commonly have few blades, need at least an 8 mile-an-hour wind, and can attain very high speeds.

4. What does a windmill look like?

There are many different types; here are 8 examples:



5. Can I buy a wind generator?

Various different brands of wind generator were manufactured and sold in this country until the advent of the Rural Electric Coops in the 1950's. After that there was a slack period for about 20 years, when the only electricity-generating windmills were very small (about 200 watts) 'Windchargers', manufactured by Dynatech in Sioux City, Iowa. Now other companies are getting into the act: Kedco (9016 Aviation Blvd, Inglewood, CA 90301) is selling models as large as 2,000 watts, and several other companies are expected to begin wind generator production within the year. (D7)

6. Can I build a wind generator?

Several outfits sell plans for building your own, but you should be sure of what is required in the way of tools,expertise, etc. before you begin; it isn't easy. Sencenbaugh Wind Electric (Box 11174, Palo Alto, CA 94306) sells a kit (partially assembled) for $1400 for a 12-volt, 1000 watt generator; and Kedco (see question #5) will soon be coming out with a kit for its 1200 watt model. Helion (A32) sells plans for a 1200 watt generator for $10.00.

7. Can I fix up an old wind generator?

It can be done--if you find one in O.K. shape. The hardiest ones built in the 20's-50's were the Jacobs Wind Electrics (invented in Wolf Point, Montana), and they are the ones that have survived best. However, farmers and ranchers who own these old machines are beginning to realize their value and either hang onto them or charge very high prices for them. Mike Hackleman's book (D2) tells about rebuilding old Jacobs Wind Electrics.

8. What do you do when the wind stops?

There are 3 possibilities:

a. Quit using whatever runs on electricity for the time being.
b. Use an energy storage system. The most practical at this time is still the lead-acid battery, but other possibilities are: (1) Pumped water storage. Restricted to areas with a large elevation difference and/or large volumes of water. Montana's reservoirs have good potential for this (A6-i). (2) Hydrogen production by electrolysis of water, together with a fuel cell which produces electricity from hydrogen, or together with a program for hydrogen fuel use. Still under development. (3) Super flywheels. Still under development. (4) Compression and storage of air. Still under development, and only practical for large-scale use.
c. Install a synchronous inverter. This device must be used in conjunction with your regular utility power system. It converts the direct current (D.C.) from your wind generator to alternating current (A.C.) of standard voltage; it directs any extra current generated by your wind generator into the utility line for use elsewhere; and it directs utility current into your home if your wind generator isn't producing enough. In effect, it allows you to use the power company as a 'storage system'. The only synchronous inverter being sold at this time is the Gemini, from Windworks (D7).

9. How much electricity can I get from a wind generator?

All wind generators have a 'rated output' of wattage; this is the best they can produce, and this output is generally reached at a wind speed of about 25 miles per hour. The output increases (up to the rated output) by a factor of 3 each time the wind speed doubles; in other words, if the output is 5 watts at 10 mph, then at 20 mph the output would be 125 watts. John Obermeier's thesis Wind Electric Power Generation in Montana (D3), is a good source for information on the rated output of various wind generators and on what you can expect in your area; another excellent source for this information is the Montana Energy Conservation Plan (A6-i) .

Wind generators--particularly home-size ones--won't produce the huge amounts of electricity used (and very often wasted) in American homes today. Your first step in coordinating your wind generator's production with your electricity use is to analyze how

you use electricity, determine what you need and what you don't need, and proceed accordingly.

10. In what ways can I use this electricity?

Electricity from wind generators can be used in conventional ways (lighting, appliances, etc.); can be used for resistance heating of water (D6); and can be used to produce fuel (hydrogen gas) through electrolysis of water.

11. What about large-scale wind systems?

Large-scale wind systems look very promising: Dr. William Hemonemus of the University of Massachusetts has proposed economical large-scale wind energy systems for areas of the U.S. (including the Northern Plains area) with a good wind resource; the U.S. National Aeronautics and Space Administration (NASA) has built and is testing a 100 Kilowatt wind generator at its Plum Brooke Station near Cleveland, Ohio, and NASA plans to build four more large wind generators at various locations in the U.S. by 1980; Senator James Abourezk of South Dakota is promoting the use by REA's of large-scale wind generators tied in with existing electrical utility grids in the plains areas of the U.S.; the electric utility serving Block Island, off Rhode Island, is installing wind generators to supply the island with electricity; and a recent study by General Electric for the U.S. Energy Research & Development Administration (ERDA) concludes that large-scale use of wind energy could provide 102% of the country's electricity generation.

12. Could present utility networks use wind-generated electricity?

Yes. (see question #8) According to Ernst Cohn of NASA, "Pick the areas of the U.S. where they have the right kind of wind velocity, and the right kind of wind durability, and put your windmills up and feed their power into a grid. You use them as base power, with no storage...on a day when you have no wind--which will probably not happen for all windmills anyway--you use conventional fossil fuel power, and peak power plants.

13. What about windpower costs?

The Montana Energy Conservation Plan includes a summary of the estimated cost associated with various candidate windpower systems at Montana sites, establishing that wind electricity will cost from 1.5 to 3 cents per kilowatt hour to generate at the windier Montana sites (A6-i).

On a small scale, wind generators off the shelf are still quite costly -- in the order of $5,000-$10,000 for a good system producing 300-400 kilowatt hours per month. However, on a life-cycle basis (figuring all the costs, including fuel, over the lifetime of a system), wind generators are already competitive in some areas, and as fuel prices rise will look better and better.

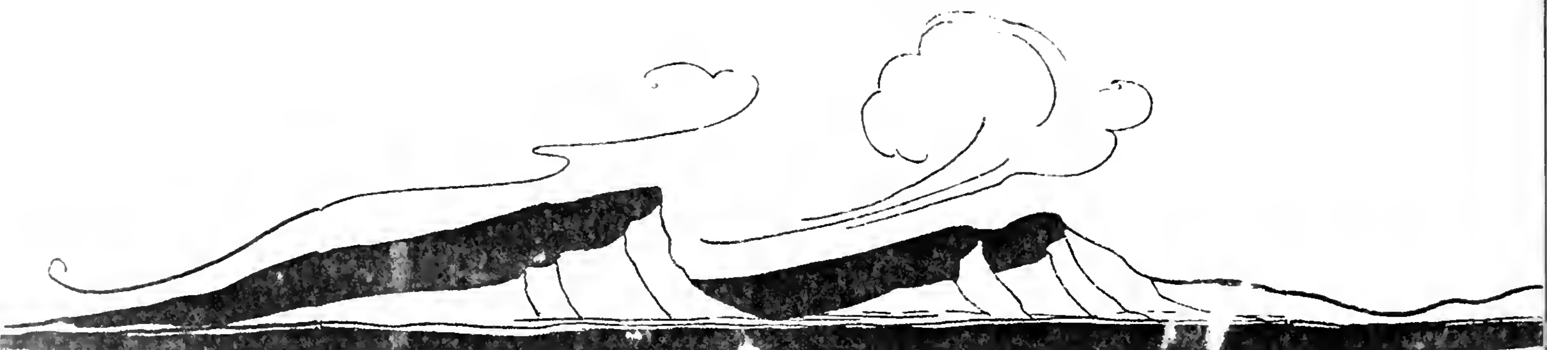
14. Is the federal government funding research and development on wind power?

More and more. ERDA has a wind program in its solar energy division: its administrator is Louis

Divone. The wind program receives far less money than do many of the other solar programs, but it has a project underway building and testing large-scale (100 kilowatt - 2 megawatt) wind generators, and has recently established a program at Rocky Flats, Colorado, to test and evaluate (and eventually develop) small (1-3 kilowatt) wind generators.

15. Is there an organization I can join which promotes wind power development?

Yes. The American Wind Energy Association (AWEA) was established in 1974, and has been growing by leaps and bounds. It sends out an excellent newsletter 4 times a year, and membership is $25 annually ($10 for just a newsletter subscription). Contact Ben Wolff at Windworks (D7) or Mike Evans at Wind Power Digest (D5).



BIOGAS (METHANE) FROM ORGANIC WASTE

1. What are organic wastes?

Any wastes which are derived--either directly or indirectly--from plants.

2. Which organic wastes have potential for producing biogas in Montana?

Sewage; feedlot, hog farm, dairy farm and chicken farm wastes; crop residues; food processing residues (from canneries, sugar beet factories, etc.); kitchen vegetable scraps (A6-j).

3. How can organic wastes be converted into biogas?

a. By anaerobic digestion. This is a decaying process which must take place in the absence of air (oxygen). (A6-j, E1, E2, E3)
b. By pyrolysis. This is a complicated, energy-intensive and large-scale technology which uses high heat to break down wastes to gases. It has not been developed to a commercial stage. (A6-j)

4. What is a biogas (or methane gas) digester?

An insulated, airtight container which mimics and hastens the anaerobic digestion process.

5. What is methane gas, and what's the difference between it and biogas?

Methane is a combustible gas with a heat value of about 896-1069 Btu/cubic foot (as compared with propane, which has 2200-2600 Btu/cubic foot). It is the main component of most pipeline gas, and is the burnable component of biogas (which also contains carbon dioxide, nitrogen, and traces of other gases). Because biogas contains non-combustible gases, its heat value is about 540-700 Btu/cubic foot; 'scrubbing' biogas (run-

ing it through various materials which take out the non-combustible gases) will improve its heat value.

6. How much biogas can you get?

The general rule is: one cubic foot of gas per pound of liquid waste.

7. Can an individual home, ranch or farm use a biogas digester?

According to California's Office of Appropriate Technology, "Production of methane from a single household is rarely worth the cost and effort for the amount of energy produced. The productivity of methane plants in colder climates is greatly reduced because of the energy that must go back into keeping the plant warm enough to operate. However, as a growing number of plants testify, practical amounts of methane can be produced with a neighborhood or larger operation."

8. How much does a digester cost?

A small digester made from a 55 gallon drum or something similar can be very inexpensive; it depends on what you can scrounge and what you have to buy. A large digester is expensive; the 250-cow capacity digester built by Ecotope Group (E1) cost on the order of $100,000.

9. How can the biogas be used?

Biogas can be used for the same purposes as pipeline gas is used: cooking, heating, etc.

10. Can biogas be stored?

Biogas is usually stored in a large tank with a top that fits inside it (made airtight by means of a water jacket) which can rise and fall with the amount of pressure exerted by the gas flowing in or taken out. (E1, E2, E3) It is not practical to compress or liquify biogas, because of the amount of energy that must be used to do this.

11. Does anaerobic digestion of organic wastes produce anything else useful?

Yes. It produces excellent, odorless, insectless, nitrogen-rich fertilizer. George Oberst of Biofuels (E4) considers the fertilizer to be the most important product of anaerobic digestion.

12. Can biogas production be accomplished on a large scale?

Yes. In Montana, the best places for anaerobic digesters would be city sewage plants, feedlots, and food processing plants. (A6-j) The town of Wilton, Maine, is presently using a solar-heated anaerobic digester for its sewage wastes.

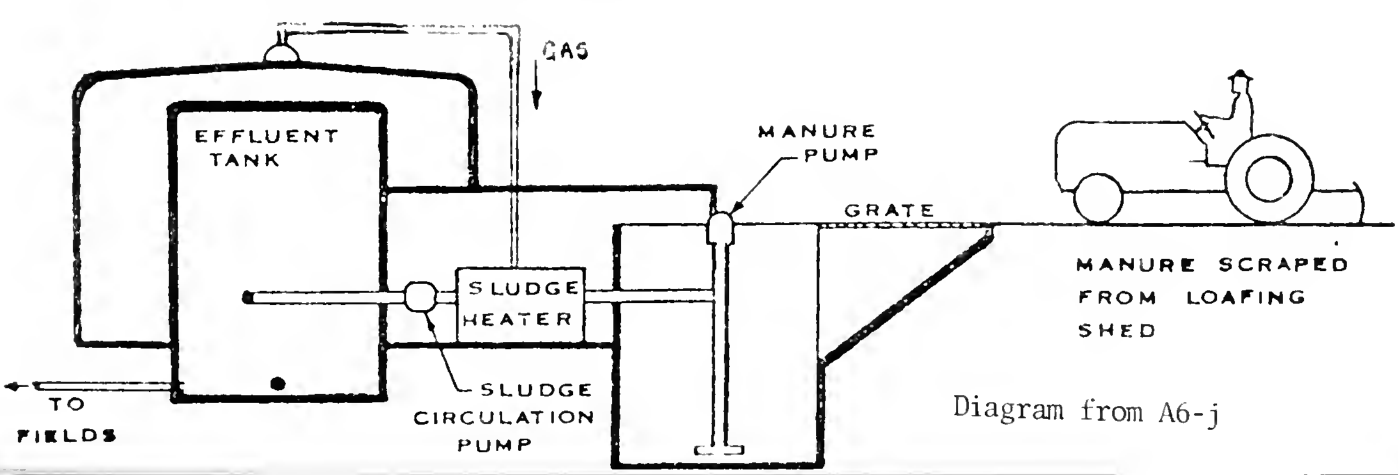


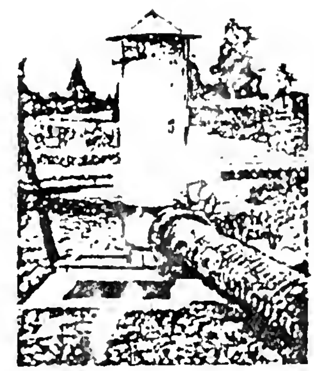
Diagram from A6-j

SMALL-SCALE HYDRO

Most of the large and easy-to-develop hydroelectric sites have already been tapped in this country. The potential for small-scale water-powered systems has not yet been considered because of conventional, large-scale economic thinking. There are abundant untapped streams and waterfalls in Montana, particularly in western Montana where rainfall is greatest. Many small communities and some individuals could harness the power from this falling water to supply their electrical demands. Some mechanical energy needs can also be met with simple water wheels. (A6-p)

1. How can I utilize small-scale hydro power?

   With a water wheel or a water turbine. (A6-p)



1 K. W. Unit on a Ranch in Montana.

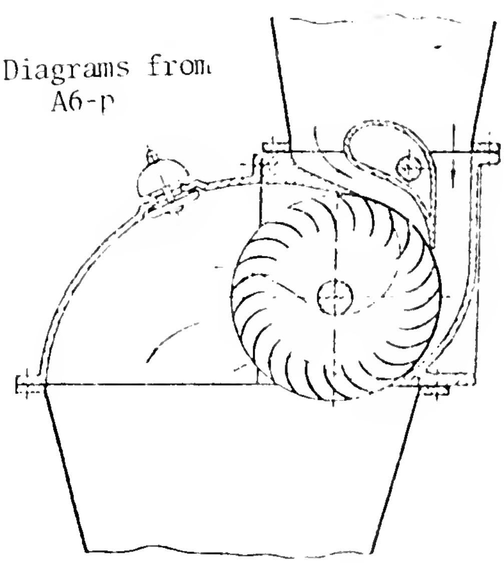
2. What is a water turbine?

   A water turbine produces electricity. There are 3 main types:

   a) Reaction Wheel. A propellor is turned by the fall of water through a duct or pipe in which the wheel is confined.

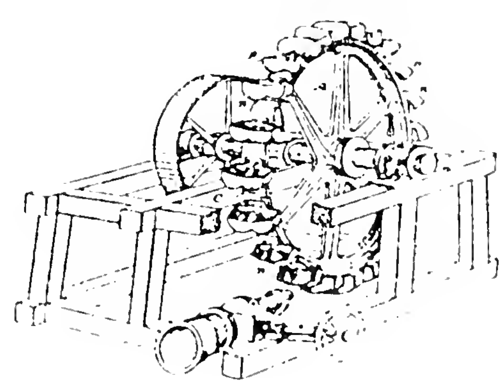
   b) Cross-Flow Turbine. (Mitchell or Banki turbine). This can be constructed with moderate metal-working skills. The curved blades in this system are designed to be hit twice by the falling water; three-fourths of the power is taken off the first pass, one-fourth off the second.

Diagrams from A6-p



Patented OSSBERGER cross-flow

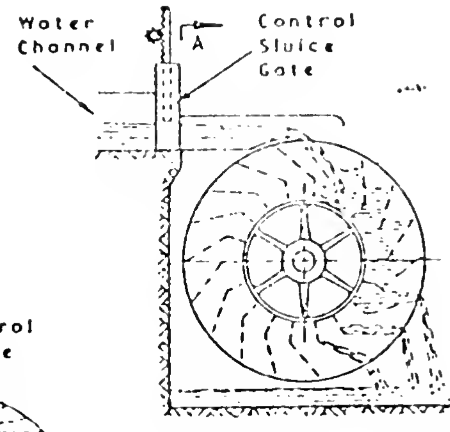
   c) Impulse, or Pelton Wheel. This type works by the force of a jet of water acting on cups mounted on the perimeter of a small wheel. No damming of the water source is required; instead, a long pipe carries a portion of the stream down to power the turbine.



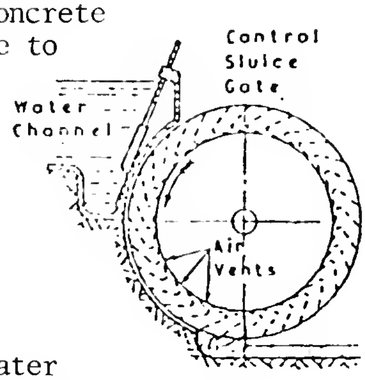
3. What is a water wheel?

A water wheel turns more slowly than a water turbine, and is used for high-torque, mechanical purposes (cutting, milling, etc.). There are 3 types:

a) Overshot Wheel. Water flows through a sluice gate to the top of a wheel of buckets, causing the wheel to turn from the weight and impact of the water.

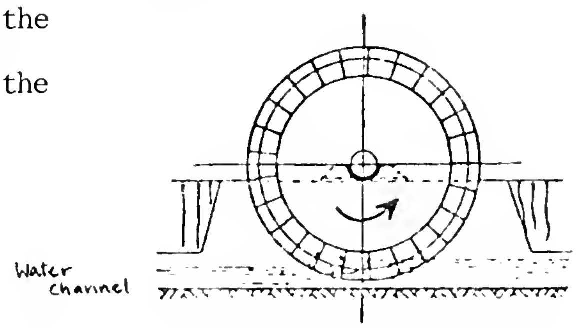


b) Breast Wheel . Water flows down into buckets that trap the water with the aid of a concrete breast that has been formed to fit close to the wheel.



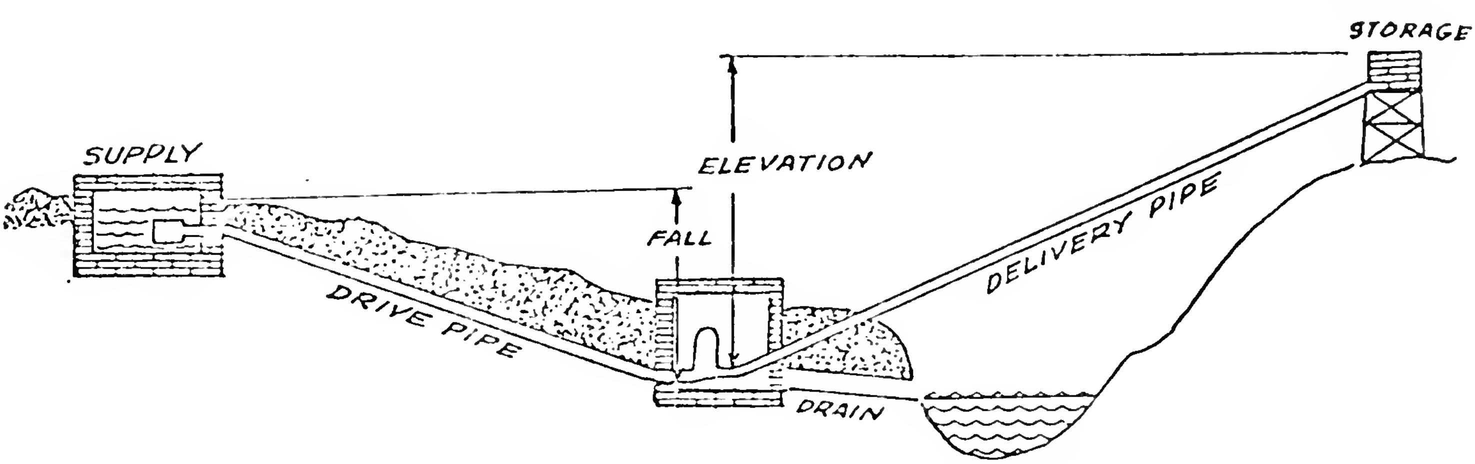
Diagrams from A6-p

c) Undershot Wheel. This is the simplest water wheel. As water flows by, paddles pick up the energy in the stream and produce mechanical energy. The low efficiency is balanced by the low cost of construction and installation.



4. What is a hydraulic ram?

This is a water pumping device that uses the energy in a small 'head' (height of water) --5-10 feet--and a small flow--1-5 cubic feet/minute--to raise ½ the flow up to 5 times the head (A6-p). It does not provide power; rather, it replaces electric pumps needing power and does the same work of moving water from where it is to where it's needed.



COMMON ARRANGEMENT OF DRIVE PIPE, RAM AND STORAGE

WOOD

There are 93 million acres of land in Montana, 25% of which is forest land. Eighty percent of western Montana is forest and twenty percent of eastern Montana is forest. Two-thirds of this is annually subject to some timber harvest, but in harvesting, only 50% of the organic matter is taken. After logging, waste is piled up and burned.

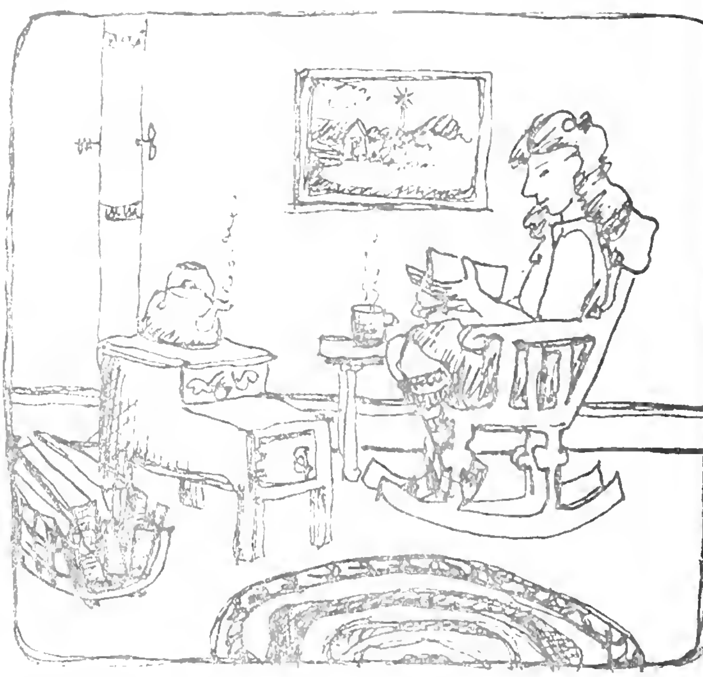
Wood is only a renewable energy resource when it is used carefully and in conjunction with a well-organized reforestation program. Huge areas of land (large parts of India, for instance) have been turned almost into wasteland because of uncontrolled wood cutting practices.

1. How can I buy firewood?

   a) Check the newspapers' want ads and the phone book's yellow pages for wood sellers.
   b) Ask around.

2. How can I get it myself?

   a) You can often get slabs and mill ends from a sawmill.
   b) Check with the local office of the U.S Forest Service or the State Forester.
   c) Construction sites sometimes have pieces they'll give away.
   d) Occasionally, you can get some from lumber yards.
   e) The local Human Resources Development Council can help low-income people obtain wood.



3. What equipment do I need for obtaining wood in the forest?

   Saw, gloves, truck or trailer, shovel, ax, bucket, earmuffs or plugs if you're using a chainsaw, hardhat (optional).

4. What types of wood are available in Montana?

   Douglas Fir, Ponderosa Pine, Lodgepole Pine, Western White Pine , Engelmann Spruce, firs, hemlock, Western Larch, cedar, Whitebark Limber Pine, cottonwood.

5. Are these useful as a fuel?

   Yes; although they are softwoods, and haven't nearly the heat content of such hardwoods as maple, ash, oak and beechwood. Dry wood gives you 20% more heat than does damp wood! So it is very advantageous to cut your wood early and store it in a dry place for 6 months before you use it.

6. How can I use wood as a fuel in my home?

   Fireplace, stove, cookstove, furnace.

7. How good is a fireplace for heating?

A fireplace is probably the most wasteful wood burner. Most fireplaces have no means of controlling the amount of air that enters them, and the rapid movement of air up the chimney can actually empty the room of warm air; air is resupplied to the room through leaky foundations and loose windows and doors, and the result is a cooler room rather than a warmer one. (A2, F3, F6)

Recent improvements include fire-resistant doors; a fireplace grate made of hollow pipes that suck in cool air and blow out warm air; a coil of copper pipe that fits in a stovepipe or chimney and heats domestic water; and a metal box that surrounds the fireplace and heats a reservoir of air that can be blown into the room. Some modern fireplaces increase efficiency by taking in air from the outside (so warm room air is not robbed) and using fans to blow the warmed air into the room. (F3)

8. What systems are more efficient than a fireplace?

a) Stoves
b) Furnaces

9. Where can I buy one?

Most large towns in Montana have at least one woodstove dealer; check the yellow pages. For a list of distributors, see appendix #5. Prices vary according to availability and quality, and can range from $100 to over $500 for a wood stove.

Wood furnaces and boilers are available; some have automatic switchovers to gas or oil-firing burners , for use in the event that the wood supply becomes exhausted. A promising new wood furnace concept is being developed in Whitehall, Montana,by a man named Darrow Hippert (Box 446, Whitehall, MT 59759).

10. What about buying a secondhand stove?

Beware of: large cracks, rusted out parts, warps, missing parts.(F1, F4, F5, F6)

11. Which is a better stove--iron or steel?

According to *High Country News* (F3), cast-iron stoves weigh more, are harder to repair, last longer, cost more, heat up slower, retain heat better, and resist warping. Sheet steel is lighter, cheaper, tends to warp and wear out, won't retain heat but heats up quickly. Cast iron doors on sheet metal stoves make them more airtight. Don't burn coal in a sheet metal stove.

12. How do I install a wood stove or furnace?

Check with your local building inspector and fire department.

13. Can wood be used in industrial processes?

The use of wood for industrial processes has been steadily increasing in the past several years in Montana. Many of the larger forest product firms (Plum Creek Lumber, Intermountain Co., U.S. Plywood) utilize wood wastes in their own in-house power production; and a few (Hoerner Waldorf's pulp mill in Missoula, St. Regis Lumber, Libby) generate electricity through the use of steam powered turbines fueled by wood wastes. (A6-j)

GEOTHERMAL

1. What is geothermal energy?

Geothermal energy is underground heat that is or can be transferred to the surface of the earth. Surface manifestations of this heat include geysers, fumaroles, and pools of boiling mud such as those found in Yellowstone Park.

Geothermal regions are usually (although not always) associated with known volcanic activity and/or earthquake zones. The actual source of heat is generally believed to be radioactivity within the crustal rocks. In the earthquake zones (theoretically positioned by continental drift) crustal weaknesses enable deep-seated heat to rise nearer to the surface of the earth.

There are four geothermal field types:

a) Hot water fields. These contain a water reservoir at temperatures ranging from 60 to 100 degrees centigrade. Such fields can be useful for space heating, agricultural and various industrial purposes.
b) Wet Steam Fields. These contain a pressurized water reservoir at temperatures exceeding 100 degrees centigrade. Such fields can be useful for power generation as well as for other purposes.
c) Dry Steam Fields. These yield dry or superheated steam at the wellhead, at pressures above atmospheric with the degree of superheat varying from 0 to 50 degrees centigrade. Such fields are also suitable for power generation.
d) Hot, Dry Rocks. Super-hot rocks below the earth's surface can be hydro-fractured; water is then forced down, turns to steam, and shoots to the surface to run an electric turbine.

2. Does Montana have good geothermal potential?

Montana shows external signs of geothermal activity. Yellowstone National Park and various hot springs scattered throughout the state are good examples of this. Montana also has a number of geologic faults classified as earthquake zones. Most of the hot springs lie within one or another of these. Montana's geothermal potential has not been explored to any great degree.

3. How can geothermal energy be used?

Major interest has been concentrated on power generation. One of the overriding reasons for this is that geothermal resources have to be exploited where they occur, which is often remote from urban areas. Electrical transmission lines make transport of power from geothermal electrical production facilities possible.

Lardarello, Italy, Wairakei, New Zealand, and The Geysers in California are well-known examples of producing geothermal power stations.

Another major use for geothermal energy has been district heating and cooling. Iceland pioneered large-scale heating of houses from geothermal sources. The city of Reykjavik has developed, owned, and operated a geothermal district heating system. Citizens of Boise, Idaho, are promoting the renovation of a geothermal system which heated many homes in the city earlier in this century. Homes, hotels, apartments and other buildings are heated by geothermal in Hungary, Japan, New Zealand, Russia and a number of other areas.

In addition to power production and district heating, geothermal energy can be used in industrial processes, fish farming, heating of swimming pools and greenhouses, and many other heat-utilizing activities.

4. Is geothermal potential being explored in Montana?

Interest in geothermal exploration in Montana has been mediocre. As of December, 1975, the BLM in Montana had received a total of 45 applications for geothermal lease, totaling 72,773.93 acres. None have been issued. No applications have been received on Montana state lands.

One major exploration project has been undertaken in Montana, known as the Marysville, Montana, Geothermal Project. This project was funded by the National Science Foundation in June, 1973. An exploration well was drilled to a depth of 6,790 feet. No commercial geothermal potential was discovered.

REFERENCES

PUBLICATIONS = All Capital letters
Periodicals = Underlined

* = AERO uses this a lot.
** = AERO sells this (at a discount to members).

AERO is a source of further information on all the topics in this booklet. (435 Stapleton Building, Billings, Montana 59101).

A. GENERAL

1. **ENERGY FOR SURVIVAL, by Wilson Clark. 1974. Explains conventional and renewable energy use from the stone age until now, and speculates on potential for the future. Stresses net energy production and social, environmental and economic constraints and advantages. Excellent, well-documented reference book. $4.50 from Anchor-Doubleday, 501 Franklin Ave, Garden City, NY 11530.
2. **ENERGY PRIMER. 1974. Detailed, clear explanations of how to use renewable energy sources. Plenty of good charts and diagrams. $5.50 from Portola Institute, 558 Santa Cruz Ave., Menlo Park, CA 94025.
3. HANDBOOK ON HOMEMADE POWER, by Mother Earth News. 1974. Information on renewable energy sources for the homestead. $4.00 from Bantam Books, 666 5th Ave., New York, NY 10019, or at your local bookstore.
4. **HOUSEHOLD ENERGY GAME, by Thomas W. Smith and John Jenkins. 1974. Excellent booklet which leads you through an assessment of your energy use and waste, and suggests ways to improve. 50¢ from U. of Wisconsin Sea Grant Program, 1800 University Ave., Madison, WI 53706.
5. **KILOWATT COUNTER, by Gil Friend and David Morris. 1975. A thorough rundown of energy equivalents, terms, uses, etc. Excellent reference. $2.00 from Alternative Sources of Energy, Rt. 2, Box 90-A, Milaca, MN 56353.
6. *MONTANA ENERGY CONSERVATION PLAN (see page 2 for authors and sponsors). 1977. The Montana Energy Conservation Plan consists of a well-documented analysis of the feasibility of implementing various methods for conserving energy in all sectors of Montana's economy, plus a thorough investigation of the possibility of utilizing renewable energies such as solar, wind, biomass, and small-scale hydropower in the state. The Plan consists of 16 separate documents:
    a) The Montana Energy Conservation Plan
    b) Energy Conservation in the Residential Sector (Working Paper #1)

c) Energy Conservation in the Commercial Sector (Working Paper #2)
d) Energy Conservation in Industry (Working Paper #3)
e) Energy Conservation in Transportation (Working Paper #4)
f) Energy Conservation in Agriculture (Working Paper #5)
g) Energy Conservation in Government (Working Paper #6)
h) Solar Energy (Working Paper # 7)
i) Wind Energy Systems (Working Paper #8)
j) Biomass Conversion (Working Paper #9)
k) Wood Fueled Direct Combustion (Working Paper #10)
l) Direct Coal Combustion (Working Paper #11)
m) Geothermal Energy (Working Paper #12)
n) Montana Energy Conservation Plan: Implications for State/Local Governmental Relations (Working Paper #13)
o) Energy Conservation Implications of the State Commission on Local Government, Proposed Code (Working Paper #14)
p) Small Scale Hydropower (Working Paper #15)

The Plan is not yet published, but copies are available for reading in the following places:

AERO Office
MEAC Office (A36)
NCAT (A37)
Billings City/County Library
Bozeman Public Library
Butte Public Library
Glasgow City/County Library
Great Falls Public Library
Helena Public Library
Kalispell City/County Library
Miles City Public Library
Missoula City/County Library
Eastern Montana College Library
Northern Montana College Library
Montana State University Library
Montana Tech Library
University of Montana Library
Western Montana College Library
Montana Historical Society Library (in Helena)
Montana State Library (in Helena)

7. **OTHER HOMES AND GARBAGE, by Leckie, Masters, Whitehouse and Young. 1975. Basically the same topics that Energy Primer covers, but with slightly different emphasis: fewer references, somewhat more comprehensive and coordinated coverage. Beautiful graphics, charts. $9.95 from Sierra Club Books, 530 Bush St., San Francisco, CA 94108.
8. **RAINBOOK: RESOURCES FOR APPROPRIATE TECHNOLOGY, by the editors of RAIN: Journal of Appropriate Technology. 1977. This is AERO's most useful reference book. 256 pages, fully indexed, of just the right information to point renewable energy enthusiasts in the directions they are seeking. Combines information from the last 2½ years' RAIN Magazines with new details on compost toilets, solar greenhouses, woodstoves, solar and wind energy, etc. $7.95 from RAIN, 2270 Northwest Irving, Portland, OR 97210.
9. *THE ROAD NOT TAKEN, by Amory Lovins. 1976. First published in Foreign Affairs Magazine, this superb treatise on energy strategy appeared later in Not Man Apart (Friends of the Earth's newsletter) under the title "The most important issue we've ever published." Everyone should read it, to know just exactly why we can't go on wasting energy the way we do. It's the most lucid, logical and compelling argument for decentralization, appropriate technology development, and renewable energy utilization that AERO has ever seen. 50¢ from Friends of the Earth, 529 Commercial St., San Francisco, CA 94111.
10. **SHARING SMALLER PIES, by Tom Bender. 1975. The philosophy behind using such appropriate technologies as renewable energy. Lifestyle and attitude changes. Well-written, articulate. $1.50 from RAIN, 2270 NW Irving, Portland, OR 97210.
11. **AERO Sun-Times. Newsletter of the Alternative Energy Resources Organization (AERO). Monthly, $10/yr from AERO, 435 Stapleton Bldg., Billings, MT 59101.

12. *Alternative Sources of Energy. Articles, networking, interviews, reviews, regular columns--all on small-scale, decentralized use of renewable energy. Excellent, gets better all the time. Bimonthly, $10/yr from ASE, Rt. 1, Box 90-A, Milaca, Minnesota 56353.
13. *Elements. Well-researched news on resources, energy, agriculture on an international scale. Monthly, $7/yr from 1520 New Hampshire Ave., NW, Washington, DC 20036.
14. Energy Legislation. Lists energy legislation introduced and enacted by the States. Bi-weekly, $25/yr from Council of State Governments Energy Project, Iron Works Pike, Lexington, KY 40511.
15. *Environment Magazine. In-depth articles, sometimes on energy. Monthly, $12.75/yr, from Environment, 560 Trinity Ave., St. Louis, MO 63130.
16. *Environmental Action. Action-oriented information and news; very helpful. Bi-weekly, $15/yr from Environmental Action, 1346 Ct. Ave., NW, Washington, DC 20036.
17. *Environment Action Bulletin. Short bits and long articles on energy, environmental and agricultural issues. Bi-weekly, $10/yr from Rodale Press, Emmaus, PA 18049.
18. *High Country News. Excellent, in-depth reporting on renewable energy action in the Rocky Mountain States. Bi-weekly, $12/yr from HCN, Box K, Lander, WY 82520.
19. Mechanix Illustrated. More and more often, they are printing articles about renewable energy. 60¢ at your newsstand.
20. *People and Energy. Excellent coverage of citizen action on energy. Monthly, $10/yr from People & Energy, 1757 'S' St., NW, Washington, DC 20009.
21. *Popular Science. Continually increases its coverage of renewable energy information. 75¢ from your newsstand.
22. *Solar Utilization News (SUN). A newsletter with several unique features: one is a section which describes various renewable energy patents which have been recently issued; the other is a section listing and describing publications which have recently become available through the National Technical Information Service (NTIS). Handy regional format. Monthly, $8/yr from SUN, Box 3100, Estes Park, Colorado 80517.
23. *RAIN: Journal of Appropriate Technology. Energy/environment/community/lifestyle /networking bulletin board. Stuffed with great information and references. Monthly, $10/yr from RAIN, 2270 NW Irving, Portland, OR 97210.
24. *Solar Energy Research & Development Report. Informative 4-page biweekly report from the Solar Energy Division of the U.S. Energy Research and Development Administration (ERDA). Free, from Div. of Solar Energy, ERDA, Washington, DC 20545.
25. Alternative Energy Resources Organization (AERO). Citizens education organization. Non-profit. Produces renewable energy information, pamphlets, workshops. Sponsors New Western Energy Show. Monthly newsletter, Sun-Times. 435 Stapleton Building, Billings, Montana 59101. 259-1958.
26. AERO West. AERO's western affiliate, located in Missoula. Emphasizes educational curricula, workshops. Scott Sproull, 529 S. Higgins, Missoula, 59801. 549-0666.
27. Jim Baerg. Designer, builder. Worked as head technician for the 1976 New Western Energy Show. Has conducted many solar water panel workshops and designed and built a passive solar home. 513 N. Black, Bozeman, MT 59715.
28. Patrick Binns. Renewable energy legislative expert. Helped produce the Montana Energy Conservation Plan (A6). 808 8th Ave., Helena, MT 59601.
29. Ecotope Group. A very active consulting and research team with much experience designing and building renewable energy devices and systems, and preparing research reports. Helped produce the Montana Energy Conservation Plan (A6). Ken Smith, Evan Brown, Davis Straub, David Baylon, Lee Johnson. 747 16th Ave., East, Seattle, WA 98112. 206/322-3753.
30. Energy Research & Development Administration (ERDA). This is the federal agency responsible for renewable energy programs. Washington, DC 20545.
31. Michael Fieldman. Works for the Human Resources Development Council in Bozeman, and teaches a renewable energy course at Montana State University. c/o District 9 HRDC, 15 S. Tracy, Bozeman, MT 59715. 587-4486.

32. Helion. This renewable energy design, research and consulting group is headed by Jack Park. They have much experience and expertise, and have designed the wind generators being manufactured by Kedco (see Wind Power Question #5). Box 4301, Sylmar, CA 91342. 367-8291.
33. Dale Horton. Teaches a course on renewable energies at the University of Montana. Dept. of Environmental Studies, U of M, Missoula, MT 59801. 549-2179.
34. Montana Dept. of Community Affairs. Their energy program under Jim Parker is very actively promoting energy conservation and renewable energy development for low-income people. Capitol Station, Helena, MT 59601. 449-3420.
35. Montana Dept. of Natural Resources & Conservation. Their Energy Planning Division administers Montana's renewable energy laws (see Solar Energy Question #20, and Appendix #4). Charles Greene is in charge of the Bill 86 law, and Mike Moon of the Bill 663 law. 32 South Ewing, Helena, MT 59601. 449-3780.
36. Montana Energy Advisory Council. Montana's state energy agency. Energy conservation, renewable energy information. Capitol Station, Helena, MT 59601. 449-2946.
37. National Center for Appropriate Technology. A young, promising organization funded by federal agencies to promote the research, development and demonstration of environmentally and socially non-destructive technologies through gra... and information dissemination. Oriented toward low-income people. Jim Schmidt, Beth Sachs, Blair Hamilton. Box 3838, Butte, MT 59701. 723-6533.
38. Randy Reinhart. Technician for the 1976 New Western Energy Show, Advance Man for the 1977 New Western Energy Show. Gives talks, slide shows. c/o AERO (A25).
39. John Obermeier. Author of a thesis on Montana's wind energy potential (D3), works for an engineering firm in Great Falls which does energy conservation analyses for buildings. c/o Drapes Engineering, 202 Eklund Bldg, Great Falls, MT 59401.
40. Steve Ottenbreit. Staff member of AERO for a year, and now works for Con'eer Engineering. Does consultation work on solar energy and wind energy. 1629 Ave. D, Billings, MT 59102. 252-3237.

B. CONSERVATION

1. **THE CASE FOR ENERGY CONSERVATION, by Denis Hayes. 1976. Concise, articulate, very well-referenced. Convincing. $2.00 from Worldwatch Institute, 1776 Mass. Ave., NW, Washington, DC 20036.
2. *IN THE BANK, OR UP THE CHIMNEY, by the U.S. Housing and Urban Development Adm. 1976. Good information on options for home heating and cooling improvements. $1.95 from Chilton Book Co., Radnor, PA 19089.

-----MONTANA ENERGY CONSERVATION PLAN. (see A6).

3. *PROJECT RETRO-TECH: INSTRUCTOR'S KIT FOR HOME WINTERIZATION. Well-assembled information and guide. Free from Federal Energy Administration, Office of Weatherization, Washington, DC 20461.
4. *SAVE ENERGY, SAVE MONEY, by Eugene and Sandi Eccli. Excellent! Tips and suggestions for tightening up your home. Published by the Office of Economic Opportunity, and you can get a copy free from your local Human Resources Development Council or from the Montana Dept. of Community Affairs (A34).

C. SOLAR

1. THE DAWNING OF SOLAR CELLS, by David Morris. 1976. Thorough and encouraging rundown on the latest news about photovoltaic cells. Economic predictions. $2.00 from the Institute for Local Self-Reliance, 1717 18th St. NW, Washington, DC 20009.
2. DIRECT USE OF THE SUN'S ENERGY, by Farrington Daniels. One of the classics; a good introduction to solar energy. $1.95 from your local bookstore.
3. **THE FOOD AND HEAT PRODUCING SOLAR GREENHOUSE, by Rick Fisher and Bill Yanda. 1977. Economical, home-built solar attached greenhouses, described by people who have a lot of experience in designing and building them. $6.50 from John Muir Publications, Box 613, Santa Fe, NM 87501.

4. *PRACTICAL SUNPOWER, by Rankins and Wilson. 1976. Good how to-build descriptions of solar devices. $4.00 from Lorien House, Box 1112, Black Mt., NC 28711.

-----SOLAR ENERGY (Working Paper #7, Montana Energy Conservation Plan, see A6-h)

5. SOLAR HEATING AND COOLING ENGINEERING: PRACTICAL DESIGN AND ECONOMICS, by Kreider and Kreith, 1975. This book is for engineers. Thorough and detailed. $22.50 from McGraw Hill, Washington, DC.

6. **THE SOLAR HOME BOOK, by Bruce Anderson and Michael Riordan. 1976. Energy conservation, passive solar design, active solar systems, solar greenhouses...this is the most important recent solar design book. $7.50 from Cheshire Books, Church Hill, Harrisville, NH 03450.

7. **SUNSPOTS, by Steve Baer. 1975. Steve is a solar inventor; besides being full of good information, this little book gives you an intriguing view of how his mind works. $3.00 from Zomeworks, Box 712, Albuquerque, NM 87103.

8. SURVEY OF SOLAR DRYERS, by Brace Research Institute. Excellent description of 24 different crop, food, and lumber dryers. Photos, diagrams, cost estimates. Ask for price, from Brace Research, McDonald College, McGill University, Ste. Anne de Bellevue, Quebec, Canada.

9. **TILLY'S CATCH-A-SUNBEAM COLORING BOOK. by Tilly Spetgang & Malcolm Wells. 1975. A funny and appealing but highly educational booklet. Good for adults as well as kids. $1.50 from Solar Service Corp., Cherry Hill, NJ 08003.

10. **TURNING TOWARD THE SUN, by Patrick Binns. 1975. Excellent rundown on solar state legislation as of December 1975. $2.50 from the National Conference on State Legislatures, 1405 Curtis St., #2300, Denver, CO 80202.

11. *<u>Solar Age</u>. This is the first magazine-format publication devoted to the promotion of solar energy development. Well-presented articles, reviews, interviews, news, reader service card. Monthly, $20/yr from Solarvision, 200 E. Main St., Port Jervis, NY 12771.

12. <u>Solar Energy Digest</u>. Pertinent news on solar and solar-related energy. Monthly, $28.50 per year, from Box 17776, San Diego, CA 92117.

13. *<u>Solar Energy Intelligence Report</u>. Comprehensive reporting on federal issues, current events, budgets, codes, laws. Bi-weekly, $90/yr from Box 1067, Silver Spring, MD 20910.

14. *<u>Solar Engineering</u>. Magazine of the Solar Energy Industries Association. Lots of good information, lists of manufacturers, products, solar homes and buildings, and a free reader inquiry service. Monthly, $10/yr from Solar Engineering, 8435 North Stemmons Freeway, Suite 880, Dallas, TX 75247.

------<u>Solar Utilization News</u> (See A22)

15. Malcolm Lillywhite. Has been teaching people of all ages how to build passively heated solar greenhouses (and building them himself) for seven years. Has detailed slide shows on the subject. His organization, Domestic Technology, Inc., holds hands-on week-long solar greenhouse-building workshops for groups. Box 2043, Evergreen, Colorado 80439.

------Jack Park (see A32)

16. Jerry Plunkett. One of the original solar energy inventors and designers in this country. Also very knowledgeable on energy conservation. Has started a Center for Innovations in Butte to aid appropriate technology-oriented inventors with small grants. Box 3809, Butte, Montana 59701.

17. John Reynolds. Professor of architecture at the University of Oregon. Has had much experience in analyzing solar heating and cooling possibilities in the Northwest. He and his students have written excellent booklets on the subject. Center for Environmental Research, U. of Oregon, Eugene, OR 97403.

18. Solar Energy Industries Association. Has a comprehensive list of current manufacturers and marketers of solar hardware. Write to Solar Engineering (B14)

19. Bill Yanda. Has helped low-income families in New Mexico design and build solar greenhouses, and has written a book (B3) on the subject. Is available for consulting or lectures. Rt. 1, Box 107-AA, Santa Fe, NM 87501.

D. WIND

1. **SIMPLIFIED WIND POWER SYSTEMS FOR EXPERIMENTERS, by Jack Park. Excellent basic book. Highly recommended. $6.00 from Helion, Box 4301, Sylmar, CA 91342.
2. THE HOMEBUILT, WIND GENERATED ELECTRICITY HANDBOOK, by Michael Hackleman. Step-by-step instructions on rebuilding, building, installing, etc. Photos, diagrams. $7.50 from Earthmind, 5246 Boyer Rd., Mariposa, CA 95338.
3. *WIND ELECTRIC POWER GENERATION IN MONTANA, by John Obermeier. Excellent study of wind energy possibilities in this state, with power output and economic analysis for various types of wind generator. $5.00 from Dept. of Mechanical Engineering, Montana State University, Bozeman, MT 59715.

-----WIND ENERGY (Working Paper #8 of the Montana Energy Conservation Plan, see A6-i)

4. **WINDWORKS POSTER, by Windworks. An incredible amount of nicely-consolidated information; one side shows the power output versus potential of various types of windmill, and the other side has all the basic wind energy information. $3.25 from Windworks, Rt. 3, Box 329, Mukwonago, WI 53149.
5. *Wind Power Digest. This is the best periodical on wind energy. Excellent articles, beautifully laid out, with good photos. Interviews, news, etc. Qtrly, $6/yr from WPD, 54468 CR 31, Bristol, IN 46507.

-----American Wind Energy Association (see Wind Power Question #15)
-----ERDA Wind Energy Program (see Wind Power Question # 14)
-----John Obermeier (see A39)
-----Jack Park (see Helion, A32)
-----Rocky Flats Wind Energy Program (see Wind Energy Question #14)

6. Woody Stoddard. Woody worked for years with Dr. William Heronemus of U. of Mass., helping design and build a combination wind/solar heated home on the campus of the university. Woody has much experience in the designing and building of fiberglass wind generator blades. 299 Amity St., Amherst, MA 01002.
7. Windworks. An engineering consulting firm dealing with wind energy and related educational information. These are the people to consult about the Gemini Synchronous Inverter. In addition to their comprehensive Wind Energy Bibliography ($3), and the Wind Energy Chart (D4), they now have an excellent descriptive brochure which provides (in addition to information about themselves) lists of government wind programs, prototype wind machines being developed, commercial machines for sale, and a list of distributors. Hans Meyer, Ben Wolff, Clint Coleman. Rt. 3, Box 329, Mukwonago, WI 53149.

E. BIOGAS

1. **ANAEROBIC DIGESTION OF DAIRY COW MANURE AT THE STATE REFORMATORY HONOR FARM, by Ecotope Group. 1975. Thorough description of a successful large-scale methane digestion system, plus basic methane information. $8.00 from Ecotope, 747 16th Ave., East, Seattle, WA 98112.

-----BIOMASS CONVERSION(Working Paper #9, Montana Energy Conservation Plan. See A6-j)

2. **COLD REGION EXPERIMENTS WITH ANAEROBIC DIGESTION FOR SMALL FARMS & HOMESTEADS, by George Oberst. 1975. Important regionalized information. $3 from Biofuels, Box 609, Noxon, MT 59853.
3. **METHANE DIGESTERS FOR FUEL GAS AND FERTILIZER. by L. John Fry and Richard Merrill. 1973. All the basic information, well-written. $3.00 from New Alchemy Institute, Box 2206, Santa Cruz, CA 95063.

-----Ecotope Group (see A29)

4. George Oberst. He's been experimenting with small-scale methane digesters for years, and is particularly knowledgeable about the fertilizer they produce. Box 609, Noxon, MT 59853.

F. WOOD

-----BIOMASS CONVERSION (Working Paper #9, Montana Energy Conservation Plan. See A6-j)

1. *THE COMPLETE BOOK OF HEATING WITH WOOD, by Larry Gay. Very good basic information. $3.00 from Garden Way Publishing, Charlotte, VE 05445.
2. FIREWOOD FOR YOUR FIREPLACE, prepared by the U.S. Forest Service. 25¢ from the Superintendent of Documents, Washington, DC 20402. Document number 0100-03195.

-----ENERGY PRIMER (see A2)

3. *HIGH COUNTRY NEWS'S WOOD STOVE GUIDE, by Bruce Hamilton. Excellent information, particularly for the Rocky Mountain region. 50¢ from HCN, Box K, Lander, WY 82520.
4. MAINE TIMES'S FIELD GUIDE TO THE WOOD STOVES, by Maine Times. Compares many available stoves. 30¢ from Maine Times, 41 Main St., Topsham, ME 04086.
5. RAIN MAGAZINE'S CONSUMER'S GUIDE TO WOOD STOVES, by the editors of RAIN:Journal of Appropriate Technology. Compares many available stoves. 75¢ from RAIN, 2270 NW Irving, Portland, OR 97210.
6. WOOD BURNER'S ENCYCLOPEDIA, by Jay Shelton and Andrew Shapiro. 1976. Results of an energy efficiency study of various kinds of wood heaters, examination of how creosote forms in a chimney, and many more facts for the serious wood stove user. $6.95 from Vermont Crossroads Press, Box 333, Waitsfield, VT 05673.
7. Wood Burning Quarterly Magazine. Excellent new magazine, with articles, reviews, news, contacts. $4.95 a year, from 8009 34th Ave. South, Mpls, MN 55420.
8. Wood 'n Energy. Very informative 6-page newsletter of the Society for the Protection of New Hampshire Forests. $5/yr from SPNHF, 5 State St., Concord, NH 03301.

G. SMALL SCALE HYDRO

-----SMALL SCALE HYDROPOWER (Working Paper #15, Montana Energy Conservation Plan, A6-p)

1. WINDMILLS AND WATER MILLS,by John Reynolds. 1975. Photographs, diagrams, and detailed descriptions of mechanical power-producing windmills and water mills around the world. $8.95 from Praeger Publishers, 111 4th Ave., New York 10003.
2. Canyon Industries. They have developed, and now sell, the 'Hydromite' electricity-producing water turbine. 5346 Mosquito Lake Rd., Deming, WA 98244.
3. Independent Power Developers. William Delp. They sell impulse turbines, and Bill Delp is available for consultation. Box 1467, Noxon, MT 59853.
4. Small Hydroelectric Systems. William Kitching. They sell small pelton-type impulse turbines. Box 124, Custer, Washington 98240.

H. GEOTHERMAL

1. ASSESSMENT OF GEOTHERMAL RESOURCES OF THE U.S., edited by D.E. White and D.L. Williams. 1975. Free from the U.S. Geological Survey's Branch of Distribution, 1200 S. Eads St., Arlington, VA 22202.
2. GEOTHERMAL ENERGY--REVIEW OF RESEARCH & DEVELOPMENT, edited by H. Christopher H. Armstead. UNESCO Press, 1973.
3. GEOTHERMAL OVERVIEWS OF THE WESTERN U.S., by David N. Anderson and L.H. Axtell. 1972. $8.00 from the Geothermal Resources Council, Box 1033, Davis, CA 95616.

----GEOTHERMAL (Working paper #12, Montana Energy Conservation Plan. See A6-m)

4. *STATE POLICIES FOR GEOTHERMAL DEVELOPMENT, by Douglas M.Sacarto. 1976. Available from the Renewable Energy Resources Project, National Conference of State Legislatures, 1405 Curtis St., 23rd Floor, Denver, CO 80202.
5. The Geyser. International geothermal bi-weekly newsletter. $85/yr from Box 1525, Beverly Hills, CA 90213.
6. Bureau of Land Management, Granite Tower, Billings, MT 59101.
7. Department of Geology, Montana State University, Bozeman, MT 59715.
8. Department of Geology, University of Montana, Missoula, MT 59801.

9. Montana Department of Natural Resources and Conservation, Energy Planning Division. 32 South Ewing, Helena, MT 59601.
10. U.S. Geological Survey, Helena, Montana 59601.

I. ENERGY & AGRICULTURE

1. ENERGY UTILIZATION IN VERMONT AGRICULTURE. A two-booklet study of energy and agriculture in Vermont, published in 1976. Excellent evaluation and information, useful to anyone associated with agriculture. Parts 1 and 2, $1.50 each; summary, 50¢; from Center for Studies in Food Self-sufficiency, Vermont Institute of Community Development, 90 Main, Burlington, VT 05401.
2. RADICAL AGRICULTURE, edited by Richard Merrill. 1976. Puts together writings by some of the foremost experts on agriculture. Large section on energy and agriculture. $6.95 from bookstore. (Harper Colophon Books, CN 337)
3. *Acres, USA. "A voice for eco-agriculture." Well-established and well-done newspaper with low-energy, alternative agriculture emphasis. Monthly, $5/yr from Box 1456, Kansas City, MO 64141.
4. *Maine Organic Farmer and Gardener. A great bargain: beautifully-done newspaper with well-organized reports, energy info., contacts, news. $2.50/yr, bi-monthly from MOFAG, Box 373, Kennebunkport, ME 04046.
5. Mother Earth News. Directed toward homesteaders. Lots of renewable energy information, ideas and contacts. Bi-monthly, $10/yr from Box 70, Hendersonville, NC 28739.
6. Organic Gardening and Farming. Good information and articles on renewable energy as related to farming and gardening. $7.85/yr, monthly from Rodale Press, Emmaus PA 18049.
7. *Small Farm Energy Project Newsletter. This newsletter reports on the progress of a project introducing energy-saving and renewable energy-utilizing techniques on a number of small farms in Nebraska. Very informative and well-done. Free from Nebraska Low Energy Project, Center for Rural Affairs, Box 736, Hartington, Nebraska 68739.
8. *Tilth Newsletter. Excellent alternative agriculture newsletter from Washington State. Emphasizes energy, networks of information, co-ops, contacts. $5/yr from Rt. 2, Box 190-A, Arlington, WA 98223.

J. ARCHITECTURE & DESIGN

1. *BUILDING VALUE, by Tom Bender and Lane DeMoll. 1977. This 100-page book was written as a guide for designing state government buildings. It's a superb resource, invaluable to anyone designing a building (or getting one designed). Value analyses by various criteria, design guidelines, lifecycle information, masses of information on energy systems (including such things as insulating window shutters, storing heat in building materials, underground construction and window placement), externalized costs, and best of all a really unbeatable set of references...very highly recommended! $3.25 from the Office of the State Architect, Box 1079, Sacramento, California 95805.
2. *ENVIRONMENTAL DESIGN PRIMER, by Tom Bender. An important blend of philosophy and design, oriented toward renewable energy, energy conservation. $5.00 from RAIN, 2270 NW Irving, Portland, Oregon 97210.
3. LOW-COST, ALTERNATE HOUSING FOR MONTANA. A project done in late 1975 by the Architectural Projects and Research Dept of Montana State University. Complete with working drawings. $5.00 from them at Montana State University, Bozeman, Montana 59715.
4. *LOW-COST, ENERGY EFFICIENT HOUSING, edited by Eugene Eccli. Good articles by experts on such things as financing, design, codes , construction, insulation, etc. $5.95 from Rodale Press, Emmaus, PA 18049.

5. THE OWNER-BUILDER AND THE CODE, by Ken Kern, Ted Kogon and Rob Thallon. 1976. The best information available on owner-building and dealing with building codes which are often outmoded, not applicable, or absurd. $5.00 from Owner-Builder Publications, Box 550, Oakhurst, CA 93664.
6. *THE OWNER-BUILT HOME, by Ken Kern. The classic. A must for anyone contemplating building. Four volumes in one, on a)site and climate, b) materials and skills, c) form and function, and d) design and structure. $7.50 from Owner-Builder Publications, Box 550, Oakhurst, CA 93664.

-----THE SOLAR HOME BOOK (see C6)

K. CATALOGS

1. *A-Z SOLAR PRODUCTS. Industrial components, experimenter kits, plans, literature, gadgets. Catalog free from 200 E. 26th St., Minneapolis, MN 55404.
2. *EARS CATALOG. Large selection of books, articles, plans, blueprints, posters, bumperstickers, T-shirts. Updated regularly. Free from Environmental Action Reprint Service, 2239 E. Colfax, Denver, CO 80206.
3. *JAMES L. RUHLE & ASSOCIATES CATALOG. Excellent narrated slide shows on renewable energy. Free from Box 4301, Fullerton, CA 92631.
4. *SUN CATALOG. Tremendous number of solar components you can order, plus books, insulation, gadgets, T-shirts, and a 'Solar Primer' informational section in the catalog. $2.00 from SUN, Box 306, Bascom, Ohio 44809.

APPENDIX #1

GREENHOUSE BUILDERS

In the Fall of 1976, 13 Montanans (Directors of Human Resource Development Councils in the state) took a 2-week course with Domestic Technology Institute in Evergreen, Colorado, during which they built a solar greenhouse and learned how to teach other people to do the same. For information on building solar greenhouses, contact these people:

1. <u>Hugh Reynolds</u>
   Central Montana District Council
   Box 302, Roundup, 59072
   323-2547

2. <u>Roger King</u>
   District 11 HRDC
   207 E. Main
   Missoula, 59801
   728-3710

3. <u>Ken Boggs</u>
   (same address & phone as Roger King)

4. <u>Ken Picard</u>
   Butte-Silverbow Anti-Poverty Council
   Box 3485, Butte, 59701

5. <u>Walt McCarthy</u>
   District 9 HRDC
   15 South Tracy
   Bozeman, MT 59715
   587-4486

6. <u>Bob Haddock</u>
   Opportunities, Inc.
   Box 2532
   Great Falls, 59401
   761-0310

7. <u>Carl Gladue</u>
   (Same address and phone as Bob Haddock)

8. <u>Gary Gaub</u>
   Action for Eastern Montana
   Hagenston Building,
   Glendive, 59330.
   365-3364

9. <u>Dennis Goetz</u>
   (Same address and phone as Gary Gaub)

10. <u>Dennis Balyeat</u>
    DCA, 1424 9th Ave.
    Helena, MT 59601
    449-3420

11. <u>Jim Parker</u>
    Center for Social and Environmental Concerns
    710 11th Ave.
    Helena, MT 59601
    449-3420

12. <u>Wayne Cross</u>
    District 4 HRDC
    Box 1509, Havre 59501
    265-6744

13. <u>Dick King</u>
    (Same address and phone as Wayne Cross)

RENEWABLE ENERGY GRANTS

In 1975, the Montana legislature passed a law which provides 2½% of our coal tax for funding renewable energy projects grants (see Solar Energy Question #20). The following people received grants under this law in 1976:

1. Kenneth Nordvedt, Jr.
   Physics Dept., MSU
   Bozeman, MT 59715
   --solar pre-heater for hot water system of a 11-unit apt. bldg.
2. James E. Taylor
   2715 Airport Way
   Helena, 59601
   --solar heating and energy-efficient cooling in a home.
3. Gordon Whirry
   Rt. 1, West, Box 151
   Great Falls, MT 59401
   --solar greenhouse (refused the grant)
4. AERO
   435 Stapleton Building
   Billings, 59101
   --The New Western Energy Show.
5. Valiant C. Norman
   1205 Fox
   Bozeman, 59715
   --solar heated water for a vegetable garden
6. Gary L. Owen
   7001 Bitterroot Rd
   Rt. 5, Msla 59801
   --solar space and water heating, home.
7. Martin Peterson
   101 Grant--Chamberlain 2B
   Bozeman, MT 59715
   --small-scale aquaculture with solar heating.
8. Charles Herndon, P.E.
   Montana Tech
   Butte, MT 59701
   --solar space heating.
9. Shermon S. Cook
   Lincoln, MT 59639
   --solar space heating, adapted to both new construction and to existing buildings.
10. Drapes Engng Firm
    202 Eklund Bldg.
    Great Falls, 59401
    --wind data gathering for phase 1 of a wind program.
11. LeRoy Gustafson
    Cutbank, MT 59427
    --designing, building, wind tunnel-testing a paddlewheel-type windmill.
12. Robert M. Zychek
    Rt. 1, Box 89-A
    Bozeman, MT 59715
    --space and water heating with a fireplace.
13. John Fischer
    Jocko Hollow Camp-Ground, Arlee 59821
    --establish resource center with models and research.
14. Charless Fowlkes
    5 Faculty Court
    Bozeman, MT 59715
    --solar/wood space heating.
15. Charless Fowlkes
    (same as above)
    --solar radiation monitoring at 20 different locations.
16. John R. Means
    Rt. 5, Pattee Canyon
    Missoula 59801
    --solar/wood space heating.
17. Bill Delp
    Independent Power Developers, Box 1467,
    Noxon, MT 59853
    --20 KW wind system.
18. Bill Delp
    (same as above)
    --installation of 3 6 KW hydroelectric systems in Montana.
19. James Coons
    208 N. 29th, Suite 212
    Billings, MT 59101
    --solar space heating, water heating, cooling for home.
20. William M. Spilker
    Box 244
    Helena, MT 59601
    --geothermal hot water for space heating.
21. Thomas M. Power
    Bass Creek Commune
    Stevensville, MT 59870
    --integrated solar, wood, wind system.
22. Richard [illegible]. Sheridan
    Dept. of Botany, U of M
    Missoula, MT 59801
    --solar collectors with tracking mechanism and storage system.
23. Ken Boggs
    District 11 HRDC
    207 E. Main
    Missoula, MT 59801
    --hot air solar space-heating systems on low-income homes.
24. S. Richard Hagan
    Montana State U.
    Bozeman, MT 59715
    --wood heating of water with storage.
25. Fred Shafizadeh
    Wood Chemistry Lab
    U of Montana, Missoula 59801
    --utilization of wood residues for energy.
26. Mike Stoltz
    109 5th Highland Park
    Glendive, MT 59330
    --solar heated home.
27. Jerry D. Plunkett
    MERDI, Box 3809
    Butte, MT 59701
    --Center for Innovation, to promote development and introduction of alternative energy technology.

28. John E. Robbins
Dept. of Chemistry
Montana State U.
Bozeman, MT 59715
--laboratory-scale anaerobic digester to produce fuel and fertilizer from livestock wastes.

29. David Leavengood
Bridger Canyon RR 2
Bozeman, MT 59715
--solar heated home.

30. Ralph V. Kroon
Belgrade Public Schools, District #44
Belgrade, Montana 59714
--feasibility study for solar heat application to new junior/senior high school.

31. L. Clark MacDonald
Bootlegger Trail
Great Falls, Montana 59401
--retrofit of existing home for solar heating.

APPENDIX #3

MONTANA CITIZENS' ADVISORY COMMITTEE ON ENERGY

Montana's Citizens' Advisory Committee on Energy was named by Governor Judge in early 1976, and began formal meetings on March 2, 1976. It has divided itself into sub-committes, each of which investigates a separate aspect of energy in Montana. The various subcommittes are headed by the following people:

1. Ron Erickson
Dept. of Chemistry
U. of M., Missoula 59801
(Subcom., Alt. Energy)

2. Kye Cochran, AERO
435 Stapleton Bldg.
Billings, Montana 59101
(Subcom., Alt Energy)

3. Claudia Meloy
805 S. Rodney
Helena, Montana 59601
(Subcom., Alt. Energy)

4. John Reuss
Environmental Quality Council
1228 11th Ave.
Helena, MT 59601
(Subcom., Use of Remaining Gas)

5. Clay McCartney
636 Indiana
Chinook, Montana 59523
(Subcom., Use of Remaining Gas)

6. Tom Power
Dept. of Economics
University of Montana,
Missoula, Montana 59801
(Subcom., Use of Remaining Gas)

7. Joe Angell
Travis Creek
Helena, Montana 59601
(Subcom., Energy Conservation)

8. Dorothy Bradley
Box 931
Bozeman, Montana 59715
(Subcom., Energy Conservation)

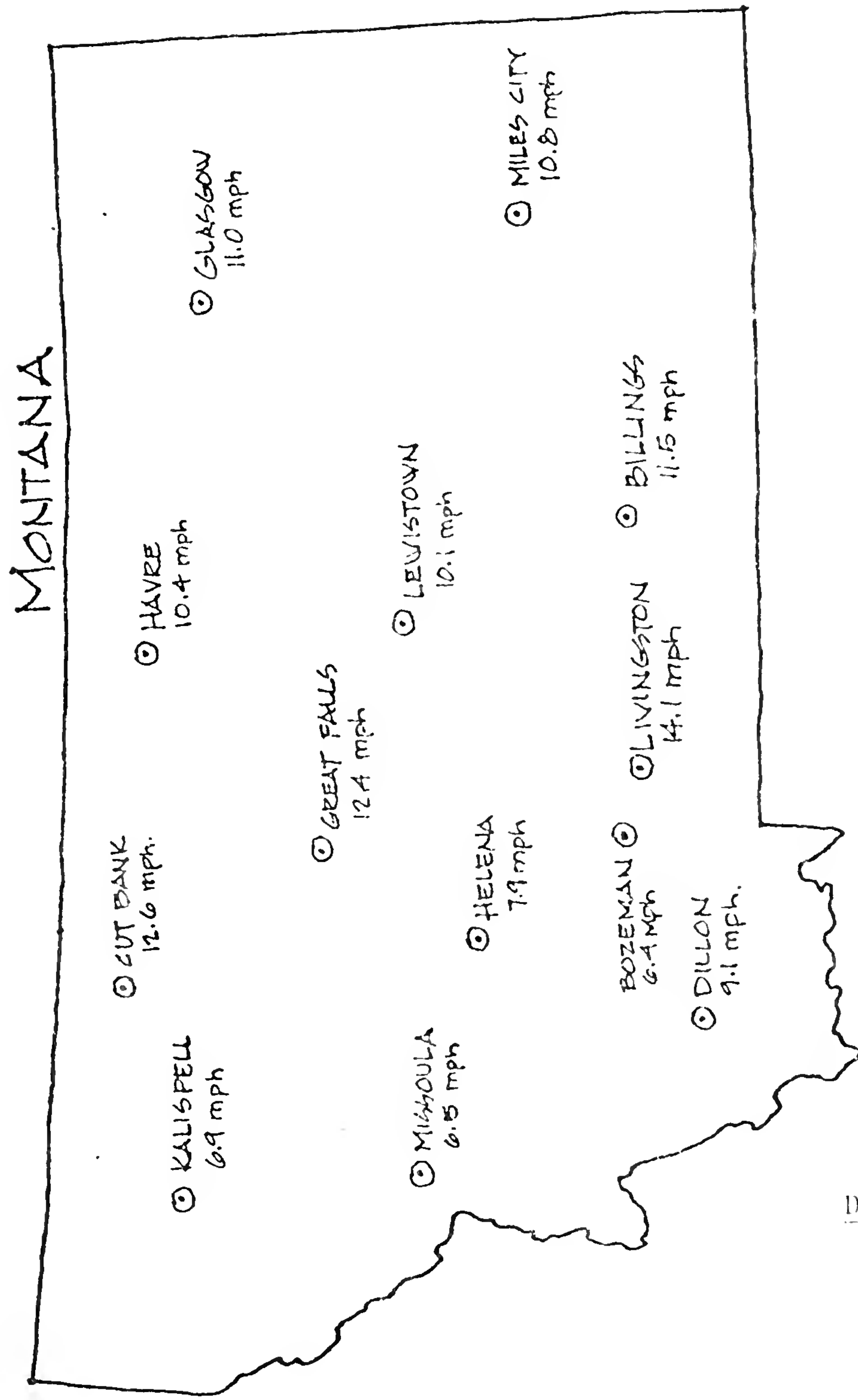
9. Sam Sperry
1823 Highland
Helena, Montana 59601
(Subcom., Energy Conservation)

10. Hugh Schaefer
School of Law
University of Montana
Missoula, Montana 59801
(Subcom., Legal Issues)

11. James Robischon
Suite 400, Silver Bow Building
Butte, Montana 59701
(Subcom., Legal Issues)

12. Mary Ellen Connolly
Box 214
Whitefish, Montana 59937
(Subcom., Legal Issues)

APPENDIX #4



LOCATIONS OF AVAILABLE WIND DATA
(mean annual wind speed indicated for locations)

Diagram from A6-i

Stove distributor directory

The following is a list of major stove distributors. For a list of local dealers contact the distributors. Drawings from **Maine Times.**

SCANDINAVIAN AIRTIGHT STOVES

Jotul:
Kristia Associates
449 Forest Ave.
Portland, Maine

Lange:
Scandinavian Stoves, Inc.
Box 72
Alstead, N.H. 03602

Morso:
Southport Stoves
Division of Howell Corp.
1180 Stratford Rd.
Stratford, Conn. 06497

Trolla:
Lyons Supply
Manchester, N.H. 03100

DOMESTIC AIRTIGHT STOVES

Sunshine:
Sunshine Stove Works
Norridgewock, Maine 04957

Ram:
Milton Hills
Belfast, Maine 04915

Fisher:
Fisher Stoves Inc.
504 South Main St.
Concord, N.H. 03301

Better 'N Ben's:
C & D Distributors, Inc.
P.O. Box 766
Old Saybrook, Conn. 06475

Tempwood:
Mohawk Industries, Inc.
173 Howland Ave.
Adams, Mass. 01220

THERMOSTATICALLY CONTROLLED AIRTIGHT

Ashley:
Martin Industries
1604 17th Ave. S.W.
Box 730
Sheffield, Ala. 35660

Shenandoah:
Shenandoah Mfg. Co., Inc.
P.O. Box 839
Harrisonburg, Va. 22801

Riteway:
Riteway Mfg. Co.
Marco Industries, Inc.
Harrisonburg, Va. 22801

MISCELLANEOUS STOVES AND EFFICIENT FIREPLACES

Warm Morning:
Locke Stove Co.
114 W. 11th St.
Kansas City, Mo. 64105

Wonderwood:
United States Stove Co.
South Pittsburg, Tenn. 37380

Monarch:
Monarch Range Co.
Beaverton, Wisc. 53916

Atlanta:
Atlanta Stove Works, Inc.
Atlanta, Ga. 30307

Birmingham Stove and Range Co.
Box 2593
Birmingham, Ala. 35202

Autocrat:
Autocrat Corporation
New Athens, Ill. 62264

Defiant:
Vermont Castings, Inc.
Prince St.
Randolph, Vt. 05060

Dover:
Dover Stove Co.
Main St.
Sangerville, Maine 04479

Arctic, Olympic:
Washington Stove Works
P.O. Box 687
Everett, Wash. 98201

Barrel stove kit:
Country Craftsmen
P.O. Box 3333H
Santa Rosa, Calif. 95402

Atlantic, Monitor:
Portland Stove Foundry Inc.
57 Kennebec St.
Portland, Maine 04104

Fatsco
251 N. Fair Ave.
Benton Harbor, Mich. 49022

A note about creosote

Creosote is formed when wood gases condense and drip back down the flue. This crusty, brown, ill-smelling goo is caused by incomplete combustion and low temperatures in the flue. It is unpleasant, and can be dangerous.

When you get creosote built up in your flue, it can catch on fire. Chimney fires can be violent blasts that catch the roof on fire. So when you start to get a creosote buildup, you should clean your flue.

Chimney sweeps in Europe use specially made brushes. A bag of chains can knock off the creosote, but can also damage masonry. One homespun method is to use an old Christmas tree on a rope. But such trees are highly combustible and can catch on fire if there are any hot sparks left in the chimney. When you clean your flue, be sure to close your damper.

Lawrence Hamilton and Fred Winch of Cornell University say that creosote problems can be largely avoided if you follow these guidelines:

1) Burn most wood gases inside the stove.
2) Use seasoned wood.
3) Connect the stove to the chimney with a short length of pipe or use double pipe. Creosote precipitates when flue temperatures drop below 250 degrees F. Shorter pipes or insulated pipes keep flue temperatures higher.
4) Line the chimney with tile.
5) Use a chimney cap to provide better draft and to keep chimney temperatures higher.
6) In mild weather, instead of a long low fire, use a short hot one, or several short hot ones.

"Creosote also results when a stove is operated beyond its basic design capabilities," notes **Maine Times.** "In a Scandinavian stove designed to burn for eight hours on one stoking, for example, attempting to achieve a longer burn by limiting the air supply will lower the firebox temperature below the temperature needed for complete combustion."

APPENDICES #5 and #6

(Taken from High Country News F3)

APPENDIX # 7

COMPARISON OF SOLAR HEATING AND COOLING OPTIONS FOR MONTANA

Taken from A6-h

System Temp.	System Type	Cost, \$/sq. ft.	Area to collect mBTU/yr sq. ft.	Capital cost, \$/mBTU/yr	Energy cost \$/mBTU	Status	Context
Room Temp. 70° F.	Double-glazed window with R-10 night door.	8.00	4.9	39.60	4.46	Standard construction practice	Passive space heating in day and portion of night depending on storage.
Hot water temperature 130° F	Flat Plate Collector. Double glazed, with selective surface	6.00 23.00	5.8	34.80 133.00	3.98 13.80	Home built. Off-the-Shelf system.	Hot water or space heating. This is one of the best flat plate collectors tested by ERDA, and yield is still low in Montana's cold climate.
	Fresnel refractive concentrator (tracking)	21.50	2.3	50.70	5.57	Off-the-shelf system.	Hot water or space heating.
220° F	Fresnel refractive concentrator (tracking)	21.50	4.6	99.08	10.40	Off-the-shelf system.	Very hot water or low-grade steam or refrigeration.
	Evacuated tube collector (stationary)	28.00	3.34	93.65	9.86		

System temp.	System Type	Cost, $/sq. ft.	Area to collect mBTU/yr sq. ft.	Capital cost, $/mBTU/yr	Energy cost $/mBTU	Status	Context
300° F.	3X concentrator with evacuated receiver.	10.00 Stat. 13.00 Track.	5.26 3.31	52.60 43.05	5.76 4.81	Prototype under construction at Argonne Labs	Costs are estimates only
600° F.	Linear concentrator; fixed mirror tracking absorber	8.04	4.26	34.21	3.92	Prototype built & tested, General Atomic Corp.	High temperature process heat costs are based on large scale installation and components made in specifically assigned mftg facilities.
	Linear concentrator; stationary absorber at focus of articulated fresnel slats.	9.32	4.26	39.65	4.47	Prototype built & tested, Itek Corp, Sheldahl Corp.	
	Linear concentrator; articulated parabolic trough.	9.36	3.85, E-W Axis 2.81, Turntable	36.04 26.29	4.10 3.12	Prototype built & tested, Honeywell Corp., Sandia Labs.	
1000° F.	Heliostat tower	26.26 thermal only; 28.76 thermal electric	2.27	59.54 200.64, If electric output only, & other heat rejected.	6.42 20.56 (70 mils per kwh)	Essential components built; prototype system to be completed in 1977.	High temperature process heat or thermal electricity. Costs based on 337 Mw thermal installation.